REPORT RESUMES

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FINAL REPORT OF THE SUMMER STUDY ON OCCUPATIONAL, VOCATIONAL, AND TECHNICAL EDUCATION.

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A SUMMER INSTITUTE WAS CONDUCTED TO PLAN NEW PATTERNS TO ATTAIN OCCUPATIONAL, VOCATIONAL, AND TECHNICAL EDUCATION GOALS. THE IMMEDIATE PURPOSE WAS THAT OF DEVELOPING CRITERIA FOR NEW INSTRUCTIONAL MATERIALS AND LEARNING AIDS FOR SUCH EDUCATION. SEVERAL RECOMMENDATIONS WERE STRUCTURED FROM THE INSTITUTE--(1) THAT THERE BE INITIATED A DEVELOPMENT PROGRAM OF NEW CURRICULAR PATTERNS AND INSTRUCTIONAL MATERIALS FOR ALL STUDENTS FROM JUNIOR HIGH SCHOOL ON, (2) THAT, SIMULTANEOUSLY AS PART OF THE PRECEDING PROCESS, PROJECTS BE INITIATED FOR TEACHER EDUCATION AIMED AT GENERATING COMPETENCE IN COOPERATIVE GROUP TEACHING WITH THE NEW INSTRUCTIONAL MATERIALS, AND ATTITUDES THAT HAVE BEEN PROPOSED, (3) THAT A NATIONAL SYSTEM OF MULTIPURPOSE EDUCATIONAL CENTERS BE ESTABLISHED, (4) THAT A PROGRAM BE UNDERTAKEN TO LEAD TO THE ESTABLISHMENT OF AN INSTITUTE OF EDUCATIONAL MANAGEMENT, PATTERNED AFTER THE BEST SCHOOLS OF INDUSTRIAL MANAGEMENT AND BUSINESS ADMINISTRATION, (5) THAT THERE BE INITIATED SPECIAL PROGRAMS FOR THE DEVELOPMENT OF TRANSITIONAL EDUCATIONAL PATTERNS IN DEPRIVED AREAS WHILE THE NEW, MORE COMPREHENSIVE PROGRAMS ARE EMERGING, AND (6) THAT PROJECTS BE INITIATED TO STRENGTHEN AND BROADEN THE APPRENTICESHIP PROGRAMS OF LABOR, INDUSTRY, AND GOVERNMENT. THE INSTITUTE PROVIDED THE BASELINE FOR ESTABLISHING NEW CONCEPTS TO AID IN RESOLVING THE INADEQUACIES OF CURRENT PRACTICES OF OCCUPATIONAL, VOCATIONAL, AND TECHNICAL EDUCATION. (HB)

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Final Report of The Summer Study

on

Occupational, Vocational and Technical Education

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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on

Occupational, Vocational and Technical Education

JULY 6 — AUGUST 13, 1965

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Abstract of the Summary Report

THE complete report of the Summer Study consists of two parts. An abstract of the first part, the Summary Report, is presented as an introduction to this Final Report.

The challenge faced by the study was to a large extent that of finding answers to the following question: What patterns of education will best prepare American youth for useful, satisfying and gainful work at the termination of formal schooling?

Despite a wide divergence of backgrounds and interests of the one hundred or so participants in the study, substantial agreement was reached on a working philosophy and on a number of major recommendations for action. Practically at the very outset of the study there emerged general agreement that any significant innovation in and improvement of occupationally and vocationally oriented education should be aimed not merely at current vocational programs but, more importantly, at the great numbers of students who fail to succeed in college preparatory curricula and are not engaged in standard vocational education. Thus, it became evident that any fundamental attack on vocational education would of necessity be directed at all education.

In attacking this general problem, a great deal of attention was brought to bear on the feasibility of introducing into educational practice new patterns of learning designed as an alternative route to higher education from those now existing. These are characterized by student involvement in investigative learning for occupational goals and involve working with materials, systems and processes as the points of entry for both intellectual and manipulative development. Concern about the status problem, that is, the early rejection from college preparatory curricula, along with the discontinuity in educational patterns at the beginning of junior high school, led to the conclusion that this level would be desirable for an introduction of the new patterns of learning. Furthermore, great emphasis was placed on the need for the organization of a body of "clinical" knowledge that synthesizes the empiricism derived from "doing" with the abstractions and principles of traditional academic disciplines. The great variation in individual student requirements for involvement in the development of skills and in academic opportunities led to a study of how a curriculum might be organized to meet adequately these dual objectives. Tightly coupled to the need for generating new curriculum materials and learning aids lies the critical problem of teacher education, both in-service and pre-service. Programs of teacher education and curriculum development are so inextricably intertwined that they must be made part of a single innovative effort. Because of this and the equally intimate interrelations with many other components of the educational process, such as testing, counseling and administration, there emerged a clear need for the pooling of the necessary resources in central locations where a total development could be carried on effectively. Other necessary functions would benefit by being part of the operations of such multipurpose centers.

The rapid change in both character and scope of the requirements for effective educational management emphasized the need for the creation of institutes of educational management of character and quality needed to prepare people effectively for the emergent needs of such management. In addition to the foregoing, attention was focused on the large and critical problems of the special educational needs for deprived areas. Also the problem of recommending changes in the objectives and practices of apprenticeship programs led to the desirability of making them primarily vehicles for continuing education. The dual requirements of great diversity and of coherent coordination in education, as well as the very tight coupling among all the components that are involved in an educational operation, made it clear that effective innovation should be tackled as a systems problem rather than as a series of independent improvements of individual ingredients.

Out of the composite efforts of the working groups of the summer study emerged substantial agreement on a number of basic issues. These are in essence as follows:

First, there is need to treat vocational-occupational education as an integral part of the common core of all education. Consequently, education should be concerned with all the capacities of an individual, including the intellectual, the manipulative, the creative, and the social.

Second, current vocational education should be expanded and generalized so that working with materials, with systems and with processes provides a base for intellectual growth along both traditional academic and vocational paths.

Third, some of the new vocational education should be part of the educational experience of *all* students and, conversely, some of the classical disciplinary type of education should be part of this experience.

Fourth, there is need, early in a student's schooling, to replace the traditional division of education into separate disciplines by an educational pattern in which current categories of subjects are not readily identifiable. This should be initiated at the beginning of the junior high school program. Such an operation will use as central facilities shops or working areas such as laboratories and will call for the development of a new kind of cooperative group teaching effort.

Fifth, the junior high school pattern of experimentally and experientially based education should evolve continuously into a few broad but closely connected avenues of education in senior high school. These should have no terminal educational goals, but rather the new programs should provide foundations for continuing education whether it be on the job or in formal post high school curricula.

Sixth, education for vocational competence should build in flexibility and adaptability to produce transferable knowledge and skills. Since formal schooling can at best provide but part of such competence, all relevant resources of society should be utilized to strengthen this educational process. The rapid change of skill requirements, both in character and in degree of sophistication, indicate that the benefits of current vocational education can best be derived at the post high school level, in parallel with the education offered by technical institutes and junior colleges.

Out of the forestated considerations and other findings of the summer study came a set of major recommendations for action. These in essence are as follows:

First, it was recommended that there be initiated a program of development of new curricular patterns and instructional materials of the type previously described for all students, beginning with the start of junior high school. This point of entry recognizes the potential of existing curriculum reforms, such as those embracing elementary science, mathematics, English and social studies, that are now being introduced at the elementary level. It was further recommended that, simultaneously and as part of the preceding process, teacher education projects be initiated that are aimed at generating competence in cooperative group teaching with the new materials and attitudes that have been proposed. Also, the establishment of a national system of multipurpose educational centers was recommended. An additional recommendation was aimed at the initiation of a program leading to the establishment of an institute of educational management, patterned after the best schools of industrial management and business administration. For the problems of deprived areas, it was recommended that a program for the development of special educational patterns be initiated. These would be characterized by a sizeable body of tightly interlocking work-study experiences with heavy civic and community involvement, reflecting the apparent present urgent and relatively early need of students from these areas for gainful employment. Finally, it was recommended that projects be undertaken to strengthen and broaden the apprenticeship programs of labor, of industry, and of government. These projects should aim primarily at the continuing education of apprentices capitalizing on the development of skills as a means for such education. These programs could generate effective roads back into further formal education with advanced academic standing.

Background

DURING the early part of December 1964, Massachusetts Senate Majority Leader Kevin B. Harrington, Chairman of a Special Commission to investigate and study educational facilities in the Commonwealth of Massachusetts, called to the attention of Dr. James R. Killian, Chairman of the Corporation of the Massachusetts Institute of Technology, the critical problems faced by current practice in occupational and vocational education and asked if M.I.T. might lend a hand in improving this situation. In response to this request, a meeting was held on December 24, 1964 at M.I.T. to receive relevant information concerning vocational education and to explore what, if anything, M.I.T. might be in a position to do that could be of assistance in improving it.

Participating in this meeting were

Dr. J. R. Killian, Chairman of the Corporation,
Dr. J. A. Stratton, President,
Dean G. S. Brown, Dean of Engineering,
Dean J. B. Wiesner, Dean of Science,

Prof. E. R. Gilliland, Head, Dept. of Chemical Engineering,

Prof. N. H. Frank, Dept. of Physics,

Prof. J. R. Zacharias, Dept. of Physics,

Dr. F. C. Colcord, Special Assistant to the Chairman,

all of, M.I.T., and

Dr. P. E. Marsh, Research Associate,

Mr. A. J. Corazzini, Research Associate,

both of the Massachusetts Study Commission on Education.

Dr. Marsh opened the meeting by describing the organizational structure and operation of vocational education in Massachusetts, both at the pre-college and post-high school levels. Some of the discussion dealt with the latter, especially with respect to the occupational programs that comprise part of the mission of community colleges and the scarcity of competent staff for these areas. Most of the discussion, however, revolved about technical education below the college level.

Dr. Zacharias stressed the need for a flexible educational approach which does not limit future development of the students and their avenues of work. The point was also made that vocational education suffers from a sense of inferiority; that students going into it are generally regarded as second-rate people who cannot survive in the college-directed programs. Dr. Killian stressed the fact that our immediate need is to deal with the people who do not go beyond high school, who are the current sources of juvenile delinquency and social problems in our slum areas. Later, Dr. Stratton stressed this point again, noting that although we must plan for the long run, we do have these immediate problems to face which require action. The boys who are dropping out of school must be stimulated by school so that they will remain there and will develop sufficient skills to play a useful role in society. Professor Frank pointed up the relationship between the high school and post-high school technical training, stressing that the high school program should be designed so that students can move upward from it, or not. The importance, again, is flexibility – to design programs which are not "dead end" programs. Dr. Zacharias stressed the need for de-emphasizing bookishness and the traditional practice of using examinations to test abilities. Other means should be provided for truly testing a man's ability to use his hands and his eyes.

Dr. Stratton mentioned the possibility of a summer study, noting that there is money available from the U.S. Office of Education for research and development. He suggested that to really attack such problems as this you needed "systematic conversation." Dr. Zacharias agreed that a summer study would be useful and urged that it be three months in duration in order for the participants to "soak" in the subject. He said in order to have a summer study program it would be necessary to begin planning work in January and that it would cost about $300,000, minimum, for ten weeks. The director would have to be appointed well before the program begins – as well as a steering group to plan it effectively.

The question of financing was discussed, and the feasibility of using the "10% Federal funds." Also the possibility of getting foundation support was mentioned. Dr. Stratton said that he thought Commissioner Keppel had control over these research funds and that he might well be responsive. Dr. Killian said we could not wait for state funds to become available in order to plan this.

Dr. Wiesner stressed that in the U.S. we will be spending a great deal of money on vocational education and on coping with the social problems related to dropouts, juvenile delinquents, etc. Having a summer study program of this kind could assure that some direction is given to the expenditure of these funds. Dr. Gilliland stressed the fact that engineering and science professors have very little understanding of the problems of vocational education and that some mechanism will have to be found to assure that the people participating in the summer study understand the problem.

Dean Brown described the system of vocational education in Australia, and said that he thought it might offer some useful guidelines to Massachusetts. He noted that all students go to the same school for 12 years and then bifurcate into two channels, the junior technical school and the junior high school. He said the former is quite "intellectual" – like a "baby M.I.T." The students go from there to senior technical high school and can go from there to a university. In Australia flexibility is provided. There is considerable stimulation of the students, and the persons choosing to go through the technical school channel are not looked down upon.

It was generally agreed that this group would meet again to discuss further the possibilities for a summer study program.

After a series of informal discussions both internally at M.I.T. and with outside individuals, Prof. Frank was asked to begin a feasibility study to explore the availability of support for and the interest and tentative commitment of qualified people in an M.I.T. Summer Study on occupational and vocational education. The interest in the possibility of such a study expressed by Francis Keppel, at that time U.S. Commissioner of Education, led to a meeting on February 17, 1965 in his office with Prof. Frank. At the meeting, Commissioner Keppel confirmed his interest and suggested that funds were available in the Division of Vocational Education that could properly be employed to support such a study. With this encouragement and indication of a means of obtaining financial support, Prof. Frank spent the next two weeks in obtaining tentative commitments for participation from individuals with a variety of professions and interests, all of which had a stake in the broad problems of education for occupational goals. These included people from the following groups: organized labor, university and college faculty (engineers, scientists, economists, architects and political scientists), professionals in public and private technical institutions, public education agencies, curriculum reform groups and people specifically involved in vocational reform efforts such as in the Massachusetts cities of Quincy and Newton. The very positive expressions of interest and willingness to become involved in a summer study made it clear that it would be indeed possible to recruit able people for such an effort.

As a consequence of these preliminary moves, it was decided to hold an organizational meeting at M.I.T. of a group of leaders in their fields to get reactions to the idea of running a summer-study program in 1965 on the vocational education needs of the United States, to lay out the basic purposes and objectives of such a program, and to discuss who should be the participants. This meeting was held on March 6, 1965 with the following people present:

H. Russell Beatty, President, Wentworth Institute
Gordon S. Brown, Dean, School of Engineering, M.I.T.
Frank C. Colcord, Assistant to the Chairman, M.I.T.
Nathan H. Cook, Professor, Mechanical Engineering, M.I.T.
Arthur J. Corazzini, Industrial Relations Section, Princeton University
Wallace Fletcher, Consultant, Newton School System
Nathaniel H. Frank, Professor, Physics, M.I.T.
James J. Hammond, President, Mass. State College at Fitchburg
Owen B. Kiernan, Commissioner of Education, Massachusetts
James R. Killian, Jr., Chairman of the Corporation, M.I.T.
Ralph Lowell, Chairman, Boston Safe Deposit and Trust Co.
Robert W. Mann, Professor, Mechanical Engineering, M.I.T.
Walter J. Markham, Director, Division of Vocational Education, Mass. State Department of Education
Paul E. Marsh, Research Associate, Mass. Education Study
Robert E. Pruitt, Superintendent, Quincy School System
Kevin H. Smith, Deputy Director, Educational Services, Inc.
Julius A. Stratton, President, M.I.T.
Robert R. Sweeney, Headmaster, Rindge Technical High School, Cambridge, Mass.

There was general enthusiasm expressed for the idea of a summer study on vocational education run by M.I.T. The discussion relating to purposes and objectives brought out the following points of agreement:

(a) It was agreed that the basic purposes should be to generate some *new ideas* in this area, to tackle the problem as one which is fresh and new, and not be bound or constrained by current practices.

(b) The question of the *level* was discussed at length, and there was general consensus that the problem could not rationally be subdivided; the programs of vocational education are largely centered in the high school and immediate post-high school, but elementary education in preparation for high school cannot be ignored, nor can the retraining of adult workers long out of school.

(c) There was a consensus that the toughest immediate problem – requiring short-range attack – is the high school. The reason is that something positive must be done about the dropouts.

(d) There was also general consensus that it is not really possible to study vocational education in the high school without reference to the other high school programs (primarily pre-college). Many present felt that the current arbitrary separation of students was undesirable, for psychological as well as educational reasons.

(e) Needing further consideration is the question of how much of this should be tackled by the Summer-Study group. It was agreed that there are short-range objectives (*e.g.*, the dropouts) and long-range objectives (*i.e.*, the reform of the whole educational system). The latter will certainly require a lengthy and expensive study, but there seemed to be a general enthusiasm for attacking it as the long-range goal.

(f) There should be a degree of "permissiveness" in the summer study's objectives and terms of reference.

In addition, the following items were considered:

1. *Participants*

   (a) It was agreed that the group present at this meeting – probably augmented by a few others – would serve as an advisory group in the planning of the Summer-Study program.

   (b) It was agreed that Professor Frank would direct the project and would select a small steering group (6 to 10 people).

   (c) It was agreed that the people to participate in the Summer-Study program might number as many as 60 (suggested by Professor Zacharias).

   (d) It was emphasized (and agreed) that these people should be drawn from a broad spectrum of backgrounds, including some people whose backgrounds bear no relevance to the problem but who are just plain bright. Specifically, Professor Frank suggested people be drawn from the following groups: (1) organized labor, (2) engineers doing teaching and research at college level, (3) industry and business, (4) professionals in public and private technical institutions (secondary and post-secondary), (5) economists and political scientists, (6) public education agencies (Federal, state, local), (7) people specifically involved in reform efforts now under way (*e.g.*, Quincy, Newton, Allentown (Pa.), etc.)

2. *Funding*

   (a) It was estimated $500,000 would be needed for the summer-study and related short-range objectives.

   (b) It was emphasized that, assuming this will be the start of a long-range reform effort, as much as $5 million will be needed.

   (c) It appears the U.S. Office of Education can supply most or all the funds for (a) above; Federal, state, and private foundation sources would be sought for the larger program.

3. *Location*

   (a) Facilities will be available this summer at Wentworth, Fitchburg, M.I.T., Rindge.

   (b) Supt. Pruitt of Quincy also said he hoped their forthcoming new Technical High School might be regarded as a laboratory for longer-range programs.

4. *The Public Image of the Vocational School*

   It was agreed that the "image" of vocational schools and their students has fallen badly. Some participants felt this question should be dealt with at the Summer-Study Conference. This was left for later consideration.

5. *A "Laboratory"*

   In the long run, such a program will need a laboratory in which to experiment with its proposals. The possibility of a regional research center for New England was raised (under the currently pending Education Act). Also, there are several schools (*e.g.*, Quincy, Newton) that are experimenting with new programs and might be willing to become "laboratories."

6. *Follow-Through*

   It was stressed that a Summer-Study Conference can only be successful if the people who have to follow through are heavily involved from the start.

7. It was emphasized that one concern of the study group should be guidance counseling. Counselors need to be reoriented to stop stressing college preparatory programs and measuring their success by this standard. Counselors must counsel *all* students and tailor their advice accordingly.

8. *Steering Group Meeting*

   It was agreed the Steering Group (once appointed) would get to work immediately and work out definite proposals within a month.

Following these deliberations, a steering committee was assembled to lay out the tactics of bringing a summer study into being. The most immediate problems were those of preparing a proposal for financial support and of recruiting suitable participants for the study. It was decided that a number of two day preliminary conferences be held to discuss general guidelines for the study and to recruit participants. However, since the study was planned for July and August, the lack of time precluded more than one such conference. As a result, a two day planning conference was held at M.I.T. on April 30 – May 1, 1965. This conference was supported by the U.S. Office of Education and involved about one hundred people of a wide range of backgrounds, and with both national and international representation. The full report of this conference has been published separately.

When assurance of adequate funding for the summer study was obtained, the process of recruiting began. During the second week of May, invitations were sent out to a number of participants in the planning conference and also requests for the names of qualified people they might suggest. In spite of the relatively short time available (about six weeks), the response was most gratifying and of some 150 invitations, about 110 accepted, either for full-time or partial participation. The summer study itself was held on the M.I.T. campus and was administered by the Science Teaching Center of the Institute.

The Format and Operational Plan

THE extreme heterogeneity and large number of participants in the summer study, complicated by the fact that more than half of the participants could free themselves for but part-time attendance, required a format and scheme of operation different from the conventional pattern of fixed agenda and scheduling. The experience of the planning conference of April 30 – May 1 had demonstrated the effectiveness of a mixed pattern of relatively small working groups and plenary sessions in dealing with a large, heterogeneous group of people. It was planned to run the summer study along similar lines. In setting up a tentative format for the study, however, Professor N. H. Frank, the director, and Professor N. B. Mitchell, the associate director, had to cope with a set of additional requirements.

Since the purpose of the study was to generate a fresh, uninhibited attack on the problem, it was desirable to operate in such a way that the individual participants would have as much freedom of thought and direction as could be made available and still see to it that the overall activities were confluent and followed the general guidelines laid down at the planning conference. Consequently, a relatively unstructured pattern was called for, along with means of insuring cooperative interaction among the working groups and the infusion of points of view germane to the mission of the study that could be obtained from sources outside the study proper. Furthermore, since the matter of non-verbal learning would evidently be central to the study, it would be desirable to have the participants carry out part of their activities by getting involved in working situations that leaned heavily on manipulative, observational and investigative approaches to learning. Thanks to Educational Services Incorporated, it was possible to implement this point of view with samples of experimental learning materials from a number of current curriculum improvement programs and with selected films that form part of the learning aids for these programs.

Because of the extremely large number and variety of possible relevant areas of activity of the proposed working groups, there was a distinct risk that a free-wheeling operation could become so fragmented and disorganized as to defeat or impede seriously the objectives of the study. Nevertheless, the constraints of a highly structured and organized operation could easily smother the sort of imaginative thinking that was called for, and this became clear from the responses of a number of participants which asked for "specific assignments." The decision was made, not without some qualms, to embark on an unstructured format for the summer study. The following memorandum was sent to all those who accepted invitations to work in the summer study as soon as their acceptances were received.

Memorandum

TO : Participants in the M.I.T. Summer Study on Vocational Education
DATE : June 18, 1965
SUBJECT: Tentative Format of the Summer Study

1) The principal objective of the Study is to formulate plans for launching new educational opportunities that will provide effective foundations on which specific occupational and vocational skills and comprehension can be built. In particular, a major thrust is to be made at the pre-vocational level for junior high school students. Because of the great multiplicity of forseeable skill requirements and the critical need for generating ability to cope with rapidly changing and increasingly sophisticated occupational requirements, it is planned to operate with small working groups.

The specific areas of study and goals of the several working groups should and hopefully will reflect the individual interests of those who comprise them. In fact, the participants will assign themselves to these groups and as a "homework" assignment, it is suggested that each participant give some thought to the sort of activity in which he wishes to engage This does not necessarily have to lie in the area of his own experience. Then if he can gather together a few others with the same interest, he's in business.

There are many relevant areas of activity for the individual working groups that will suggest themselves to you. Here are a few by way of example:

In the broad area of educational needs for preparation for Service Industries, there are the health services including hospital operations, nursing, medical and dental technicians, etc., the hotel and restaurant industry, banking, personal services, etc.

In preparation for the broad technical area, there are the production, use or processing of materials, metallic and non-metallic, design and construction, systems operations, data processing and computers, etc.

For business education, the preparation for entrepreneurship, for retail trades, for distributive trades, etc.

In the general area of the social and economic implications and their influence on design of new educational ventures, there are the special needs of deprived areas, community involvement in vocational and occupational education, educational needs as a function of regional environment, the public attitude vis à vis non-college bound education, etc.

In the important domain of teacher training and education, there are the requirements for teacher education and retraining for new educational offerings, the roles of Community and State Colleges as well as those of Technical Institutes and Universities, the development of a program of introduction of new curricula for pre-teachers, etc.

It is planned to operate the working groups with complete freedom with respect to possible changes of their goals or even of their personnel, if such changes are called for as the Study progresses.

2) Because of the relatively large number of part-time participants, the following general schedule is proposed:

Monday mornings: Orientation Session. Working groups will summarize their activities and plans. Consultants and part-time participants will be urged to start on Mondays to phase in smoothly.

Monday afternoons: Work Sessions for groups as time allows.

Monday evenings: Film Screenings at ESI Studio.

Tuesdays: Group Work Sessions.

Wednesdays: Demonstration Classes; Participation by Conferees.

Wednesday evenings: Special Speaker or Lecturer.

Thursdays: Group Work Sessions.

Fridays: Open House by two or three of the working groups. Others free to come in and join, criticize, etc.

Friday evenings: Parties, Cookouts, Dinners, etc.

Part-time participants should be available for at least one week, and as a workable minimum for the first three days (Mon–Wed) of a week.

The purpose of the day a week devoted to demonstration classes with participation by the Conferees is to help communicate the rationale and philosophy of on-going educational reforms. It is hoped that this sampling will stimulate and suggest new and fresh approaches to the problems at hand.

Remember, these are the initial plans. If better ones arise, we'll change.

It turned out that the general schedule as proposed in the foregoing memorandum was essentially followed with two important changes: First, the activities on Fridays turned into plenary sessions in which the working groups reported and were challenged and questioned. These sessions were impassioned and provocative and the involvement in them was so widespread that on occasion more than a full day was needed to get through the reports of all the groups. Second, on Mondays the orientation and briefing of new participants was left to Professors Frank and Mitchell after the first two weeks. This was urged by the membership because of their desire to continue group activities. Because of scheduling problems, a number of presentations to a plenary session took place on Mondays, following lunch. As the Study progressed, and ideas became increasingly crystallized, there was an increasing demand for more working time for the task forces and during the last two weeks the Wednesday evening lectures were omitted.

All in all, the calculated risk of embarking on a highly unstructured venture worked out exceedingly well. To be sure, the morale of the participants hit a low point about the end of the second week but improved rapidly and continuously thereafter. The initial self-division into as few as five working groups and the cross-fertilization stimulated largely by the Friday plenary sessions produced a cohesiveness of activities and thinking that prevented completely the fragmentation and disorder that might have occurred.

The Six-Week Summer Study

ON July 6, 1965, some fifty-five people convened at the Massachusetts Institute of Technology to start a six-week summer study on occupational and vocational education. Of the hundred or so participants in this study, about forty were on hand for the entire study, the rest for periods ranging from a few days to five weeks. The average attendance per day was around sixty.

The participants came to Cambridge from seventeen states and the District of Columbia and from Canada, France, and Sweden. While New England produced a bare majority, forty-seven came from outside the region. Just about one out of four participants represented operating school districts; nine more, operating vocational schools and two others, a private secondary technical school. State and federal vocational education offices produced six participants each. Twelve came from two-year technical institutes and two more from junior colleges. Eight people were employees of industry and business; twenty-two were on university graduate faculties (engineering-14, education-5, political science-2, design-1). The remainder represented foundations, occupational associations, or community development projects.

On the first day of the Study, the participants sorted themselves out into five working groups. By the time eight or ten topics had been proposed as possible topics for different task forces, one member stood up, announced his desire to consider a topic and invited others interested in it to join him. Over a dozen people followed him out of the conference room and went to work. Quickly, other groups formed; in short order the room was empty.

Each group was diverse in its composition in terms of the backgrounds of its members. For example, one consisted of a university professor of design, a retired industrial physicist, the director of compulsory education in Sweden, a French urban designer, a state director of vocational education, a senior associate from a legislative study on public education, a school committee member, three faculty members from technical institutes, a professor of engineering from Tuskegee, three shop teachers, a free lance industrial designer and a fine arts teacher from Canada.

This group got together to consider both the designing of an innovating educational system and the teaching of design in school. Another task force formed to discuss teacher education; a third, materials, processes and systems as subjects for study; a fourth, educational goals and structure for vocational objectives; a final one, students in the gray area of so-called "general" education. As the Study went on, smaller *ad hoc* working parties formed to probe a topic, report, and disband. Uniformly, the composition of such a group was a function of its members' curiosity and competence in a specific problem, not of their vested interests.

Despite such diversity and such opportunity for forming cliques, none appeared and a clear and unanimous sense of the Study began to emerge. As the summer progressed, this consensus was sharpened and refined. Each of the continuing groups interfered constructively with the positions of the others. Straightforward and clear statements of agreement took time to emerge, but in every instance they did before the Study concluded. The conference ended on a salutary note. Participants went home feeling that the whole Study had concluded by saying what every one of them wanted said in the way they wanted it said.

The tone of the conference from beginning to end was constructive, innovative, and practical. Indeed, the Study was a lesson in interdisciplinary group investigation in which some member or members eventually crystallized an idea that everyone else had alluded to.

One such idea that lay behind everybody's thinking was that the true appraisal of learning was to be found in what the individual did with it, not solely by what he said about it. This emphasis on doing is found in reports by two of the participants. One probed the evolutionary coupling between the hand and the mind in the development of the brain as a consequence of freeing the hand from locomotion and its subsequent emergence as a tool and tool-user. Another report stressed the role of the senses in coupling learning to doing. Learning involves the senses in interaction with the muscles and tissues of the body, so that what is actually learned requires a physiological response from both the stored knowledge of the brain and physical activity. Different individuals are capable of such coupling in different degrees and at different levels, but abstract mental acts and concrete experiences are parts of a single complex system. Thought is integral with and cannot be separated from the use of the body.

This originally unself-conscious but ultimately pervasive emphasis on exploiting the doing of things as a starting point for the acquisition of knowledge did not end with this simple, vague and general proposition. Participants had formed their five working parties long before this point of view became articulate. These areas of interest persisted throughout the Study despite change in task force personnel and in membership of the conference as a whole. They were, to repeat, Educational goals and structures to meet vocational objectives, The "Gray Area" Student, Design, Materials, and Teacher Education. Each group mobilized the expertise of its members (who, after all, had selected themselves) to discover or invent improvements in its area of interest. With natural differences in emphasis, however, every working party produced or implied the recommendations of every other working party. The outcome of the Study, therefore, has been a set of half-a-dozen major recommendations arising from remarkably coherent findings of the several groups. These proposals, summarized in the Abstract prefacing this Report and spelled out in the Summary Report published separately, all derive from the underlying premise that doing – investigation – can be a base for learning – knowledge. The story – and much of the importance – of the M.I.T. Vocational Education Summer Study revolves about the evolution of the recommendations out of those groups working from that principle.

Educational Goals and Structure Group

The group which set itself the most comprehensive assignment undertook consideration of general philosophical principles and of criteria for program evaluation. The question it posed was "What *over-all* educational patterns and structures can best provide opportunities for *all* youth to develop and achieve suitable vocational objectives?" The task force quickly came to grips with the assignment and went on to provide examples of the application of its principles and criteria to practical school affairs. These examples were aimed at exploring the feasibility of applying such principles in the real world of educational operations.

By the end of the first week of the Study, the group had arrived at a tentative statement of principles. These criteria held that one objective of education for all youth should be preparation for occupation; that pupils at all levels should have some occupationally-oriented education; that such schooling, part of the core of all education, should touch all of the capacities of an individual; that it should be viable in a rapidly changing technological society; that it should be open-ended, not terminal; and that it should be recognized as providing only part of the total continuing educational input to an occupational career.

The entire conference was quick to agree that these criteria should apply to all education. This task force consequently turned to consider the implementation of these principles in junior high schools. What was involved, first of all, was the revision of the regular junior high school curriculum to include some vocational learnings for all students. They debated two ways to fit such learnings into the system. One, soon rejected, was simply to expand course offerings to include vocational education. Much closer to the spirit of their criteria, however, was their ultimate recommendation to develop entirely new curricula incorporating essential parts of education for vocational objectives – the study of materials, processes, devices, and occupations. These they discussed briefly, for possibilities were quite extensive and beyond the limits the group had set for itself.

Even that brief discussion convinced them, however, that new curricula were feasible – that they could meet the criteria, were relevant to junior high schools, and could be invented.

Drawing on suggestions for such curricula coming out of other working parties, the task force on educational goals developed some implications of their principles. It seemed clear that the new instruction should lean heavily on involvement with things in the real world, the specialized characteristics of which children could investigate and be led to understand through manipulation, experiment, and analysis. No individual teacher could be expected to have enough specialized knowledge to be able single-handedly to exploit fully the potential of this approach. Consequently, to provide students with adequate leadership and guidance task forces of teachers would have to work collaboratively to utilize the new materials fully.

The next problem was that of the physical facilities needed so that groups of students and teachers could best tackle the new learning materials. Traditional classrooms certainly would be necessary but not sufficient for any such new programs. If "things" from the real world were to be poked and pried and weighed and measured and messed with and melted and pulled apart and put together and all the vital, wordless things that must be done to them in order to uncover their characteristics, then adequate space would be needed for the things themselves and for the tools of investigation and for the actual investigations. And the space would need to be centrally available, not in a corner to be used only on schedule. Realistically, existing shops and laboratories might be converted and the program made to depend on a timetable, but the structure group hoped not. What they wanted was a large, central space with movable equipment, suitable for experiment and for projects and presided over by a teacher "with broad background in the areas served by the shop laboratory."

The time and portion of the curriculum given to these pursuits in such surroundings would, of course, vary from grade to grade as well as from student to student. The program might well be rather qualitative and simple in the seventh grade and increase in scope and complexity through the ninth. This suggestion, however, was quite tentative — a single possibility from among the large number which experience would indicate. There was, however, conviction that rearrangement of the junior high school structure was feasible.

Subsequently, the task force turned to the senior high school. Here they faced new constraints. Some youngsters would leave school at the minimum legal age rather than stay to graduate. Others would seek work immediately when they graduated. The majority, probably, would plan to go on to two-year institutions or to traditional four-year colleges. The group was convinced that, no matter what revisions might be forthcoming in school curricula at no matter what level, these constraints were unalterable; only their proportions might change.

The working party accepted these limitations, but put them into an occupational context. Formal education through high school could no longer be considered terminal either by the student who took it *or by the institution which offered it*. This conviction led the group to a pair of guidelines for revising high school programs. One was that new vocational education belonged in each student's course of studies throughout high school regardless of his plans. The exact nature of this inclusion the group did not spell out beyond recommending that it capitalize on their proposed education for junior high school and that it should be broad and open-ended. Second, since students would still choose courses to fit personal interests, some would want a manipulative bias; others, an abstract, symbolic one. The working party, therefore, anticipated such demands by suggesting the possibility of loose and widely overlapping programs to accommodate them.

With such necessary breadth, this task force had begun to outline an institutional context within which investigative learning for occupational goals might evolve. Since this context differed from the existing one, the translation from old to new would require administration of high order. This problem was the next to concern the group. They began by considering what information school administrators needed in order to bring about such changes and to support staff and students in the process. This consideration led them to suggest guidelines for local school systems planning any such innovations. Further convinced that every local school should constantly plan to improve, the working party proposed the creation of research and development service centers to support innovations going on in operating schools in its vicinity. Part of this support should be to supply the considerable and varied information local administrators needed in order to plan and to effect change. Part should be to provide places where such information could be stored, plans drawn up, and changes justified. Still, the task force restricted itself to essentials, leaving particulars to specialists.

Then the group turned to the problem of the dropout for whom the most desirable solution lay, they felt, in the development of educational programs with meaning, utility, and appeal to the wavering student. The nature of the programs was left entirely open except for indicating that they required civic as well as educational resources. Furthermore, it was important to encourage dropouts back into school. In both processes, occupational guidance was critical. Counselors needed considerably more emphasis on occupational careers at every point in their program: Guidance training should stress vocational counseling more than it does at present. Counselors should develop much better liaison than most have with the industry. New materials and procedures for occupational guidance were essential. The task force wanted students guided to stay in school and to return if they had dropped out.

In the end, the Study's most all-encompassing working party invented or implied every final recommendation of the summer: It strongly favored the development of new instructional materials, and teacher education it saw as part of the identical process. These tightly coupled missions implied the need for dual purpose educational centers and, with the group's concern for administration and counseling, for multi-purpose centers. Bridging curricula for schools in deprived areas clearly were consistent with their criteria. They were explicitly mentioned in their deliberations as were all the reasons for strengthening apprenticeship programs. Finally toward the very end of the conference, a subgroup expanded this working group's reference to the need of research and development services for administrators into a recommendation for an Institute of Educational Management. These conclusions emerged from experienced and very practical concern for the basic goals of vocational education as they are to be implemented in schools.

The "Gray Area" Student Group

Another working group, the largest, considered the pupils least engaged by current educational practice. These so-called "gray area" students were the original concern of this task force. Most of its work and output, however, dealt with ways and means of reorganizing school operations to make possible effective educational opportunities for these students.

Such restructuring was, they felt, possible, even though the problems of "gray area" students appear as a large segment of those of the performance of the entire educational system. These pupils were in that proportion of the total seventh grade pupil population of any year who a) dropped out of high school (35%), b) did not continue formal education beyond high school (40%), and c) dropped out of college (40% of entrants, 10% of original population). The assumption in such accounting was that the total educational system ought to perform more effectively for the 85% of a given student population who drop out of it before graduating from college.

The group, early in its discussions, described the characteristics of those students who were the very first to break with school. They had a "poor attitude" toward education (*i.e.*, the system), a continuous history of failure and under-achievement, a sense of rejection by adults and peers, poor study habits, little sense of personal or group responsibility, lack of motivation and direction, low level of reading and arithmetic skills, and lack of knowledge of career areas or vocational possibilities. Obviously, the task force felt, the educational system was at least a silent partner to all these deficiencies. For some of these, such as lack of knowledge about career areas and low levels of skill in reading and arithmetic, schools could be held largely responsible.

Although the members of the gray-area group agreed with those in the "structure" group that school alone could not remedy all the disparities children brought into any classroom, they were convinced that schools should be more than 15% effective. The primary grades were crucial, they felt, if not the last pre-school years. However, since the conference had been convened primarily to construct, not criticize, the gray area task force proposed to build on the improvements being developed for these earlier levels and to concentrate on arrangements for the junior high school and above. The members felt that unless something is done, increasing numbers of children from junior and senior high school will be entering the labor market with increasing disparity between the skills which they have to offer and the requirements of society. As the group proceeded, they found major contributions from other groups in the Study. Gradually they formed firm opinions as to what materials and techniques would be conducive to eradicating negative student traits and establishing positive patterns. They discovered that their attack broadened when they attempted to plan an organizational structure for this one group. They had to plan across the board for all students. The gray area group therefore set itself the problem to "provide a meaningful, interrelated, functionally-oriented curriculum in a comprehensive school with vocational implications provided by experientially oriented techniques and materials."

The group's attention to actual curriculum content, however, remained general while its attention to the institutional setting for curricula grew increasingly sharp and detailed. The working party proposed using teams of teachers with large groups of students and providing "Learning Centers" where interdisciplinary investigations could take place. The emphasis was on flexible and comprehensive involvement.

Having settled into this frame of reference, group members applied themselves to special aspects of the problem. Principals conentrated on scheduling programs for large blocks of middle school students and task forces of teachers. Working with guidance counselors, the administrators devised a scheme for grouping the same student body both homogeneously and heterogeneously. They scheduled courses, days, weeks and years for all students. They drew schematic designs for new schools with learning centers. They suggested ways of organizing comprehensive high schools so as to minimize, if not obviate, tracking of students. They recommended summer work-study programs for older students and teachers alike.

Task force members from current occupational programs suggested changes in them to fit the new context: distributive education, study of the expanding role of distribution in a modern economy; home economics, the study of the entire domain of food processing and technology; business education, classroom use of the range of the modern business machinery and the use by all students in all courses of typewriters, desk calculators, and the like. Guidance counselors saw chances to increase their association with students and to improve the quality of guidance services. These reports expanded on the set of primary recommendations that the structures group had evolved. Much of the gray area group's study took for granted the development of new instructional materials or suggested it in the occupational areas they knew most about. The administrators' recommendations specifically provided for teacher education in summer work-study programs. The creation of new instructional materials and the education of the teachers to use them called for multi-purpose centers in which the two operations could be carried on simultaneously and cooperatively. The relationship between such curriculum improvement and administrative support of its institutional implications required an Institute of Educational Management.

Furthermore, with the coincidence between the characteristics of gray area students and the effects of socio-economic deprivation, the concentration of these new programs in rural and urban slums seems inevitable. Indeed, it is essential if education is to cease compounding its current errors of encouraging potential dropouts to learn no skill at all or, at best, a dead-ended one. The undoing of this comprehensive social disservice calls for reformulation of apprenticeship programs in unions, industry, and government.

Design Group

The "design" group formed with no pretense to the detachment of the structure group or to the practicality of the gray area group. This working party began by considering the differences which exist between the world of work and the world of school. The world of work is highly dynamic and differentiated in a rapidly changing and exciting civilization. The world of school tends to be stable if not static. What differentiation it possesses is comprehensive and institutionalized. It forces irrevocable choices on students when they are much too uninformed to decide. One consequence the group saw in such thorough segregation in school is to encourage dropping out, since it is next to impossible now for students to switch from the college-bound stream to the vocational and back again, or between either of them and the commercial. The flow is from college preparatory into vocational for boys and commercial for girls, or into the general course. Any such movement, however, is only for students who do not appear able to make it in the stream they are in. As a result, only the first stream enjoys the prestige of success, and numbers of students, for the sake of this status alone, stay in the college preparatory course even though the work itself might be distasteful.

The design group objected to this series of misfits among individual potentials, school programs and occupational requirements. Dropouts had grave and alarming problems finding any sort of jobs; graduates of general high school courses were faced with relatively few jobs and these with small prospects. The occupations open to vocational and commercial graduates were either shrinking or changing far more rapidly than the school programs coupled to them. The entire gray area had certified to the existence of bad system design and delineated its scope.

What the group proposed, instead, in the most general terms was a comprehensive course within which each student might at any time seek his own level without prejudice. Such a course design required the creation of new materials and of altered educational structures to create and support them.

With this first approximation in hand, the members of the group began to pull in different directions. Some moved to work with one aspect or another of the design which had been roughed out; others stayed to consider the place and application of design in the school curriculum. The latter production made the formal contribution of the group during the rest of the conference.

That contribution itself split in two directions. On the one hand, members described the importance of design in our modern world and in its schools by analyzing the consequences of no design or bad design in our modern civilization. But the group never quite managed to specify the nature of the new courses in design which they wanted. They analyzed some of the factors in the creation of artifacts. It involved the *sequence* of two processes: the educational process (to *learn*) through tools and their corresponding materials, and the vocational process (to *apply* learning) through processing methods and skills. The creation of artifacts, then, *was* vocational education—and it was also the *process* of information, a dynamic procedure for giving form to material.

The design group offered some requirements for this operation. They specified some of the creative-instructional equipment it required – chalkstick and blackboard, charcoal stick and paper, clay tools and clay – as basic tools of creative thought because their mark may be instantly erased and redesigned to follow the rhythm of thought through trial and error and constant self-criticism. There were also more permanent tools, such as pencils, crayons and brushes, whose information was much harder to get rid of. Also, the methods of processing varied with the combinations of tools and materials and with the objective of the creator.

One member of the group, keenly sensitive to the close coupling of the hand, the eye, and the mind with the verbal and hearing aspects of traditional education, described possible implementation. He concentrated on getting children beyond analysis into the second echelon of work — design or synthesis. Creative application of an idea is grounded in an understanding of all aspects of the problem. The best way to get at them, he felt sure, is to tap the senses and let the mind itself make the integration on a much higher level than we presently let it work. With school children, one just does not sit down and say, "And now we will use our eyes." The materials which are used have to be so carefully conceived that hand, eye and mind are all coupled with, enhance, and preceed verbalization. The proper development of material forces the utilization of all the senses.

Drawing on experience with a heterogeneous class of fourth-graders building towers out of plasticene, he described the problem. It was to see the way a column buckles, to feel the way a column buckles, to talk about it, to think about it. Then mathematics and mathematical manipulations could be introduced to express this behavior in another language and to allow it to be generalized. The design approach proceeded from intimate involvement with a total physical phenomenon to its translation into verbal language and then into mathematical language. Sequence, however, mattered less than using all the avenues for information so that the students eventually comprehend the idea so totally that they do not mimic it but use it. The use of ideas in new ways and new applications is synthesis — the integration of of design. This is a sophisticated process, difficult to measure and evaluate, so complex that few schools attempt it. Whole new courses and new sets of instructional materials were called for.

Finally, the task force saw a need to consider school as an artifact as, in fact, all of them had been doing. As such, it was open to the recasting required if the proposals of the group were to be brought into being. Especially necessary were large workshops easily accessible from every classroom. The implications of the design approach spread out into the system.

In the end, they recapitulated most of the major recommendations, adding a special dimension and force to them. Materials were central to design and to the new curriculum. Every bit as crucial were the teams of teachers the approach called for. This meant a strong program in teacher education. With the coupling of materials development and teacher education, multi-purpose educational centers were required. They and the new curriculum in design would have to have new educational management. While the design group did not recommend apprenticeship programs as such, their development was inherent in their concern for education as the precursor to gainful occupations, an implication requiring bridging courses in design for children in deprived areas.

Materials Group

The working party on materials took a direct approach to their selected task. They knew that new materials are a key part of modern curriculum revisions and that revised vocational-technical education without such materials was absurd. This group began by considering just what materials included in our modern technological society far transcended the elemental objects of the design group. They represented no more than a beginning, for metals had to be included, as well as fibers of all kinds. Synthetics could not be ignored, nor fluids and gases. Objects, made out of raw or processed materials, and structures with their own inherent technical characteristics bear investigation. (Buildings and chairs, for example.) Machines, engines, and tools are things also, open to study in their own right and as components of larger systems. The "black box" is as much a building block in modern electronics as a brick in construction. Finally, the ways in which these materials are produced, processed, and used and the systems into which they are organized are all part of investigative learning about them and about modern technology.

This task force first set out to devise and, where possible, conduct some rough and quick tests of the educational feasibility of some such items in the middle school. This level of entry took into account present elementary school curriculum revisions, the physical and educational development of junior high school students prerequisite to the new programs, and the educational efficiency of reaching students before they entered the labor market unskilled. The group hoped their materials program would interest pupils in additional education and in the formulation of occupational goals, introduce students to the workings of the physical world, engender respect for talents other than verbal, and demonstrate the intelligence of the verbally inept. For these purposes, their new instructional materials had to be based on the environmental interests of the students and be so open-ended as to lead to growth in future studies, to allow investigation beyond the limits of a given project, to demonstrate the need for basic disciplines, and to tap the capabilities of wide ranges of students. Further criteria were that the projects should stretch student interest, enlist learning through the senses, develop the need for semiquantitative measurement, allow recognizable progress by each student, and facilitate cooperative enterprise in investigation.

The topics they chose to explore as examples were not trivial; they included materials science, internal combustion gasoline engines, municipal water systems. Beginning with materials science had the advantage of a unified course from which the student will begin to obtain a broad, fundamental understanding of part of the world in which he lives, as well as a personal sense of his ability to control and manipulate this "world." It could also develop outwards to the symbolic world that includes the formal disciplines.

The sub-group that specialized in materials science proposed three major divisions – Creativity with Materials – Shape Manipulation (metal casting, electroforming, glass blowing, pottery-making and powder metallurgy, crystal growing, metal forging and plastic formings), Measurement of Properties of Materials, and Manipulation of those Properties. In the first division, some small crystals of different kinds were grown and some twelve-year-old sons of participants tried carving free forms in styrofoam, molding sand around them and making aluminum casts of them. The results satisfied the group of the education, technical, and intellectual feasibility of the venture. Part B of their syllabus dealt with "Measurement of Properties of Materials" which were of two kinds, physical and mechanical. The latter consisted only of the tensile properties of materials (including behavior at elevated temperature); the former, of thermal conductivity, electrical conductivity, thermal expansion, density, magnetic properties, hardness, melting point, color and transparency and opaqueness, corrosion. Part C was devoted to "Manipulation of Properties" of materials – alloying, cold-working, cross linking of polymers, heat treatment, composite fabrication, and corrosion control. The process of investigating these properties would require and use not only science, technology, and mathematics but economics, geography, and design as well – and at a minimum. At this point this subgroup left off, having demonstrated to their own satisfaction that new instruction in materials science was feasible and was likely to pay off.

The exploration of another topic in materials by a different subgroup demonstrated the coherence of the new curriculum and the freedom of approach it gave. This group proposed to have a large and heterogeneous group of junior high school students in working parties of four, disassemble and reassemble a half-horsepower, four-cycle gasoline engine, one per working party. The engine was merely to form the vehicle through which initial interest could be obtained and from which significant learning could be derived.

For example, inquiries into the function and design of head bolts might well be used to lead students to measures of tightness in terms of torque, to investigate the strength of metals in torsion and to understanding of the dependence of tightness on pitch and diameter of the bolts. Similarly, examination of spark plugs, condensers, coils and breaker points could be used as an entry into learning basic electrical phenomena and some circuitry. The role of carburetors, valve springs, pistons and a host of other vital engine parts provide equally stimulating starting points for investigation into many diverse areas of knowledge.

However, the importance to youngsters of getting the engines to run was well recognized. Consequently, attention was paid to reassembly and more specifically on the critical points that must be right if the engine is to run well. No attempt was made to be exhaustive, but a sufficient number of provocative questions and investigations were posed to illustrate the richness of this approach to learning things normally found in a number of different disciplines.

The purpose of these approaches and materials was clearly not to constrict or inhibit the educational process but to start it wherever the student may be and to allow each one to go as far as he would and could. The materials group believed that many students who are manipulatively skilled are truly intelligent and that a passion for engines was neither anti-intellectual or demeaning.

Far from stunting verbal or mathematical competence, close investigation of materials and operating devices could enhance, enrich, and strengthen it. What the approach called for was the coupling of the working world of materials, processes, devices and systems and the world of symbolic and abstract thought.

The new kind of education would require the development of interdisciplinary units which are rooted in a youngster's interest and experience and which broaden the child's knowledge, enlist his reasoning power, deepen his understanding and open new vistas for exploration. A multiplicity of such units could be based upon the analysis of systems and processes which deal with things and activities which are familiar to the youngster.

Water, for urban and suburban dwellers, is furnished and disposed of by a system. The operation of such a system calls on knowledge and experience from a wide range of standard disciplines. Some of these disciplines to which the study of water systems could lead include meteorology, hydrology, geology, geography, chemistry, physics, biology, accounting, economics, management, communications, organization theory, design, mathematics and English. Investigation of a water system takes one into a number of sub-systems – distribution, economy, sewerage, measuring, personnel, politics. Furthermore, as in the study of any system, these paths of learning cannot be entirely separate. For example, the distribution system might include study of water usage, water economy and the personnel operating and maintaining the system. Water-usage estimates imply the knowledge of such physical quantities as volume, pressure and flow rate.

The subgroup was satisfied that thorough study of water systems could open many ways to a number of more specialized analyses (including such relatively sophisticated projects as input-output measurement, the beginnings of performance evaluation, and interviewing techniques). This exploration involved many conference participants for an hour or two of work with the subgroup. They, however, devoted most of their time to development of the overall syllabus. They tested a couple segments of it with nine seventh grade boys. A map of the Cambridge, Massachusetts section was given to the boys for use in identifying Cambridge Reservoir, Stony Brook Reservoir and Fresh Pond, the places they were to visit on a field trip. Their visit at the treatment plant and pumping station at Fresh Pond included a tour through the liming room, the main building in which they saw sand and charcoal filters and the sampling stand; the chlorinating room which contained a flow chart similar to the one they had developed themselves, and the pump room where two 12 million-gallon-per-day pumps were handling the plant's normal output.

In a subsequent session, the students were led to the need of measurement of volume and density. Prompted by continuing questions about the relationship between gallons, ounces and cups and conversion from cubic inches to ounces, for example, individual students began to work at their own speeds and levels. The students were engrossed in calculation and experimentation, without a break, for two 1½ hour sessions. Perhaps the most significant result was that at least one boy, who did not express himself well verbally and had trouble with arithmetic, found ways of getting results from laboratory experiments of his own devising.

This fragmentary feasibility study revealed some important properties of this kind of comprehensive curriculum revision. First of all, what was tried appeared to be relevant to its audience and to hold their interest for surprising lengths of time. It offered pay-offs for non-verbal talents. It covered in about nine hours what three able and energetic men had devised in several weeks. In addition, what the subgroup had prepared was only a small fraction of the material a thorough study of any water system could include. This trial left few illusions. Such new studies could be devised and were well worth devising, but the process would require the mobilization of numbers of very competent people. The problem was essentially logistic and managerial; the substance and approach were clear and straightforward.

Indeed, each materials subgroup approached its task directly and unambiguously and to a depth limited only by the interest of the members. The materials working group had little difficulty in outlining appropriate instruction in their field. Since the possible experiments that could be developed seemed almost unlimited, they only offered samples of ideas and concluded that development groups involving teachers would have to create experiments in detail.

This new emphasis occupied the materials group for two weeks, for the group had no intention of proposing "teacher-proof" instructional materials. They suggested working with both teachers and materials as inseparable components (although not the only ones) of any coherent educational program. This coherence could only be given by combined development and retraining centers.

This aspect of implementation struck the group as quite straightforward and clear. They raised, however, a series of questions nearer to the essence of vocational education. Although programming and scheduling could make possible a multiplicity of arrangements for the investigation of materials, the real problem revolved around the educational and intellectual relationships between that study and traditional school disciplines. This the materials working party did not attempt to answer.

They were sure, however, that solutions to this problem lay beyond the capabilities of an isolated school system. The development of curriculum content and the education of teachers should take place where more adequate resources of personnel and funds than those available locally could be brought to bear. Consequently, they endorsed the proposal of multi-purpose centers as vehicles for mobilizing the requisite academic and technical strength to begin a meaningful investigation of that relationship.

The task force, in addition, envisioned a kind of coordinating unit for a national network of multi-purpose centers. This organizational unit would have a variety of functions. It would refine learning materials, coordinate programs to test new materials, ideas and methods, prior to widespread dissemination. It would also obtain financial support for implementation of the programs, give direction and structure to the development of learning materials, and determine the nature of experiment outlines distributed by the multi-purpose centers. The materials group had raised two important issues: What were the intellectual connections between materials science and the traditional disciplines and what should be the organizational relationships among multi-purpose centers.

In fact, the materials group proposed or strengthened every major recommendation of the study. The group proposed new experimentally based learning experiences. Their consideration of these ends, however, drove them to make the remaining proposals in order to insure the viability of their primary objective. New programs of learning were inadequate without teachers adequately educated. Program development and teacher education demanded greater resources than local schools could muster; therefore, multi-purpose centers were called for to bring new programs, teachers, and resources together. The work of multi-purpose centers had to be organized; therefore, some central agency for coordination and organization was needed – perhaps an Institute for Educational Management.

The improvement of apprenticeship programs and the development of bridging curricula for children in deprived areas were natural targets for their programs. The group's experiments had been tried by children from impoverished areas. The effects of their poverty seemed to have had little visible impact on their performance. The attempt to understand and create measures for the operation of a water system came after the students had all poked around the real thing. Disparities showed up in calculation skill but these resulted only from prior educational deprivation. The individual differences that did appear seemed more nearly personal than environmental. Furthermore, there was every reason for the study of materials to be an abiding one and to move freely between school and work. Apprenticeship, in this context, was simply another institutional arrangement, though important and fascinating, in which such study could go on fruitfully.

Teacher Education Group

The fifth major group addressed itself to the education of teachers. The working party formed on the basis of a conviction that curriculum revision would be severely handicapped unless coupled with the education of teachers. The group considered several of the personnel problems related to innovation. In the end, it examined most of the salient factors in incorporating teachers into large and continuing change.

The group's initial task was to plan in-service programs to prepare teachers for the new educational programs the other working parties were discussing. The group agreed that participants in the in-service programs should be drawn from a number of disciplines. They saw need for experienced leadership, for facilities in which the actual developments could be conducted, for provision for academic credit, and the appropriate financial support. They felt the need of coupling their operations to educational operations through promotion to attract participants, through follow-up assistance for innovating participants, and through the collection of new and relevant data for educational research.

The group felt that the teachers who took part should hopefully influence their colleagues and administrators to support the new courses locally. They also proposed recruiting teachers by teams from their schools. Use of a cooperative teaching group as a basic unit of participation had the merit of providing the members with the chance to work and learn together. Each such group should include its school principal for a sufficiently long period so that he could not only supply appropriate local administrative support but could also contribute to the generation of educational patterns that are operationally realizable.

The first task of the group, however, was to establish the kind of physical facilities where such teacher education programs could be most productive. A promising device for such performance, the group decided, was the center. A center reports directly to top management and works on its own budget. Its financing is commonly from outside sources and usually for specific support of its own work.

This relative autonomy is the source of the center's strength. It is freed to mobilize all requisite resources to mount a coordinated attack on a central problem. This mobilization would be paid for out of center funds and could include support of visiting fellows, outside consultants, graduate assistance, and participants. Managed by a small permanent staff, the center's fixed operating commitment can be minimal; its thrust, specific and flexible; its operation, closely coupled to demand.

The purpose of these arrangements was to develop examples of the course material to be taught, using an interdisciplinary approach for both the classroom and the shop or laboratory. The theoretical understanding was to be derived from meaningful experiences, so materials should facilitate investigation as a vehicle for the understanding of theory. This approach stood in sharp contrast to the use of laboratory and shop as testing ground for theory. It required experimentation as a kind of educational launching pad for gaining insight and knowledge. The point was how much learning could be got out of such investigations. This potential had to be carefully built into the new instructional materials – the concern of the materials group. The teacher education group had the mission of devising means of preparation for teachers who, working and learning together in task forces, would be competent to help students derive learning from experience with materials, systems and processes.

The most effective way to develop such competence appeared to be to encourage teachers from every discipline that related to such exploration to work together with the people who were developing the new learning materials. Teachers, knowing what went into them, would be in a strong position to help students find what could be got out of them. Teacher education and curriculum development had to be closely coupled in the same operation.

The multi-purpose center seemed a fitting vehicle for this work. Its advantages, however, extended beyond materials development and teacher preparation. Experience with previous curriculum reforms had proved the necessity of a system to follow up on the use of new programs. Users should receive continuing services from the center and provide feedback to it. Plans for such follow-up and feedback should be built in to the training program. Besides, if an investigative approach to occupational careers were to find a place in education, it would have to interact constructively with schools of education and with standard academic departments. Such interaction would best be initiated from the outside. For either purpose, both the work of the teachers and the strength of academic and professional programs stood to profit from the establishment of the centers.

One area in which pay-off would be early was in the field of educational research. All too often, it has been artificial or trivial. Since a significant portion of the work at the center would involve classroom teachers who were expected to feed back to the center information about everyday school operations, researchers could collect fresh and vital data about actual practice. Research results should also be disseminated to the participating schools and teachers.

Serious problems also existed in staffing technical and vocational programs of two-year colleges and technical institutes. Their difficulties revolved partly around vastly increasing numbers of students and escalating demands for quality programs. Agencies that could best prepare the necessary faculty were sorely needed. The group was sure, however, that preparation of technical faculty for the two-year institutions was a major component in upgrading vocationally-oriented education. This probe was merely exploratory, but it was the limit of the group's task.

Besides, the six weeks of deliberation by this group had led them to conclusions quite like those of the others. Development of new learning materials and teacher education were inseparable. The establishment of multi-purpose centers was essential to the combined mission. In addition, the group's recommendation of the inclusion of school administrators in the program of the improvement of program evaluation and educational research through use of feedback information and of the creation of a follow-up system pointed to the need for a new sort of educational management. The group's concern for teacher preparation for programs in two-year colleges was unique, but not incompatible with any other recommendation. Indeed, the proposal confirmed that the benefits accruing from some aspects of vocational education should be available to a much wider range of students and also for a longer period of education to meet the growing skill demands of society. Such expansion could provide conditions for improvement of apprenticeship education.

The one major proposal which the teacher education group did not tackle directly was transitional programs in deprived areas. This issue, however, was put to the entire conference in plenary session by participants with sound and strong convictions. They argued that no new programs could improve significantly the lot of minority groups without having a comprehensive attack specifically directed to the problems of unemployment and lack of training found largely among nonwhites. The overall program would not accomplish its major goals if it was implemented in only those areas which offer the greatest receptivity for change and the most economic support. Specific suggestions were made for special adult education, teacher training and the programs to cope with the cultural, social and economic problems of the Negro American. The participants resonated strongly to this direct statement of a critical problem. Ensuing discussion produced observations on the essence of the entire program. One, addressed to preparing teaching task forces for deprived areas, emphasized that training must help teachers and administrators see their roles as parts of a team. This kind of training enables its users to respect the position of others.

Radical but consistent kinds of shop-laboratories were suggested as vehicles for overcoming the deprivation in slums. It was evident that children from even the most affluent suburbs could learn much about the working world from working in Operation Headstart or community radio and TV, from running school cafeterias or in-school book stores, from helping to build roads, schools, and hospitals and to staff them to appropriate levels. The children locked into slums may have never done such things, but neither had suburban children. Each group saw in schooling for deprived areas a necessary component of their own recommendations. Such programs implemented the new goals and structure, emphasized materials development and teacher education, tackled the problems of the "gray-area student" directly and required new designs for schooling. In addition, programs in deprived areas would test the entire system in many ways more thoroughly than it could be tested elsewhere.

The importance of such non-classroom factors had been impressed on each group as it considered school administration and the function of management in its own program. A subgroup from the educational structure working party explored management as such. This group agreed that Service Centers should be established to serve school systems in planning, operating and evaluating programs. The subgroup felt that this mission could best be carried out at multi-purpose centers if the management of innovation locally is to be fitting and sensitive. Data relevant to new programs will have to be collected at the centers from national, regional, state and local sources. Effective use of this information will require educators and, more especially, the heavy involvement of a wide range of specialists such as demographers, sociologists, economists, political scientists, and public and industrial managers. In addition, demands for national statistics of all sorts, nationwide implications of changes in state plans, requirements for large scale evaluation of new programs, the necessity of tapping talent of the very highest quality wherever it may be, all combine to suggest the creation of a national, inter-university, educational management service center. These suggestions began to point the way for modernizing the organization and structure of American schools.

This report recognized the dynamics and potential of an emerging system and indicated that they could be organized to do a job. Some sense of the total dimensions and nature of that job had been conveyed to the conference earlier by a distinguished political scientist. He discussed the impressive growth of state and local government, which could be expected to continue. It suffered from inadequate manpower. Government, being a service, depends on its personnel for quality, which is intimately related to their preparation. Schools had done very little to prepare people to understand how government really works or to prepare people to work in government. The need for technically competent recruits for civil service was serious and would get worse.

The real problem, however, was to get reform under way in schools. This operation is not easy, for the educational enterprise, for all its size and importance, is remarkably fragmented. Its center of control rests in some twenty-five odd thousand local school districts; few of the fifty state departments of education play significant roles in planning and operational support (consulting, supervision, and the like); the federal government, increasingly heavily involved, lacks direct constitutional basis for such operational support. School people support a wide diversity of professional organizations, few of which have means for coordinating their operations.

Consequently, the educational enterprise is an operation peculiarly sensitive and vulnerable to local pressures. To use local influence as a means of stimulating curriculum reform would be a massive and virtually impossible task. To supply the goods and services which could meet local needs, and to do so in an orderly and systematic way, is legitimate and feasible. The development of new instructional materials, the education of teachers, the support of educational administrators and managers are fitting examples of such goods and services. In the Rand Corporation, M.I.T.'s Lincoln Laboratory, Educational Services Incorporated, are examples of institutions that have been created to handle in an orderly and systematic fashion the political and governmental problems of the sort raised by the recommendations of the Summer Study.

What remained for the participants was to search for areas of common agreement, if such existed, which could serve as a basis for recommendations.

Such agreement was in fact readily found. Except for organized labor, participation in the Study was as widely diverse as had been called for originally. In addition, the format and direction deliberately avoided the establishment of fixed goals for the outcome of the Summer Study. The only pre-conference "homework" assignment had stressed individual interests in vocational education; both the topics and composition of the working groups were determined by the participants themselves. The approach each group took to its self-imposed assignment had depended on the inclination of its membership. Participants came and went freely from group to group and to and from the conference itself. The Summer Study staff was organized to facilitate such flow. The only ground rules had been to have newcomers begin on Monday morning and stay a minimum of one week or, in special cases, at least through Wednesday evening.

Moreover, the provisional format of the Summer Study was both minimal and open to change by the conference membership. For instance, it had been planned to hold a plenary session on Monday mornings to incorporate newcomers into the operations of the Study. After a week or two, the regular participants stated their clear preference for spending that time in their groups and leaving the briefing session to the project director. This procedure was adopted, except that those who wished to sit in on the briefing were welcome to do so. Still, few participants spent all their working time with one group exclusively and shop talk among members of different groups was widespread and intense.

Furthermore, the activities scheduled for the whole conference turned out to be exciting and lively affairs independent of the special activities of the working parties. These gatherings came on three days of a week. On four Monday afternoons, lunch was followed by a plenary session to hear a talk about a particular phase or aspect of vocational education by a visiting authority and to discuss what he had to say. On Monday evenings, the whole membership viewed a number of the new teaching films produced by Educational Services Incorporated. These films ranged all the way from elegant and, to the nonscientist, highly sophisticated examinations of physical phenomena to revealing documentation of Eskimo technology. The value of these films for the Summer Study was implicit in their very existence. They let every participant see for himself how educational films could play an important role in the teaching of honest, varied and useful material. The films demonstrated their potential as an exciting and relevant tool which vocational education could use to reach more students and to attain greater depth of investigation.

Wednesdays added another dimension to this process. The whole day was devoted to conference involvement with samples of new instructional materials and patterns of learning. These sessions were never used for talk alone except as an intrinsic part of the instruction. The conference participants personally explored such things as the behavior of mealworms; they worked with the transparent but sophisticated behavior of liquids; they debated the validity of evidence that any fighting did occur at the Battle Green in Lexington in 1776; they were led to uncover criteria for distinguishing a poem from other arrangements of words. They were, in effect, sent to school themselves to work directly with a wide variety of innovative school materials (elementary and others). In each instance, the leader of the session was a member of the curriculum revision group responsible for developing the materials. The participants found them absorbing — but often for very different reasons. Some liked what they were asked to do; some didn't. Some found more in the investigation than the instructor chose to capitalize on. Some didn't really care what the investigation was about but found, by themselves, new, different, and exciting lessons in the materials. A balance, for instance, might supply a vehicle for determining the relative density of two materials, but it also opened up forceful approaches to the consideration of balance itself and to symmetry. What went on, in fact, on Wednesdays was the sort of transaction between materials and participants that the Study recommended between materials and people in school, students and teachers alike. In this regard, Wednesdays at the Summer Study confirmed the feasibility of the approach the conference finally proposed.

On Wednesday evenings, the participants assembled to hear and question leaders in various fields impinging on the study's general interest. A leader of the Massachusetts legislature discussed political requirements for effecting educational change, such as expanded and improved vocational education. The top administrator of a major hospital complex told of his rapidly expanding needs for all manner of medical technicians. A dean of engineering outlined the requirements and problems in revising the curriculum of his school and the relevance of such an operation to the problems confronting the conference. The president of a collegiate school of design described the program of his institution.

Fridays were open sessions for all participants. No less than half and more often the whole day was set aside for weekly reports from each of the several groups and from any subgroups which had something they wished to present for discussion. These sessions were free and intense, for, while reporters from each group had to present its work for the week, group members were welcome to react as individuals, and they did. Differences of individual opinion were aired, often to refine or clarify everybody's thinking. Scattered holders of similar ideas found each other and often enough, banded together as an *ad hoc* group for the next week.

Participants, as individuals and as groups, interacted constructively at these sessions. They went back to the tasks of their groups more perceptive and less isolated than they could have been otherwise. Each group was addressing the problems for the whole study from its particular frame of reference. Each group derived strength from every other group to further its own work and generated strength on which the others drew. Consequently, all groups made essentially the same recommendations because the task of each had required them. This ultimate cohesion did not diminish the disparity or diversity among participants; the diversity made the cohesion richer. This gain confirmed the feasibility of the Summer Study format and the strength and impact of its recommendations.

The Post Study Period

THE task of editing and evaluating the voluminous literary output of the six week study and that of formulating the principal findings and major recommendations for action turned out to be both formidable and complex. As soon as the essence of the major conclusions and recommendations became clear, they were reported verbally first to the U. S. Commissioner of Education and his Deputy and subsequently to the leadership of the Division of Vocational Education of the U. S. Office of Education in a two-day meeting.

During the period between the middle of August, 1965 (the termination of the study) and the completion of the summary and final reports, a large number of unexpected expressions of interest in the outcome of the study were received from people with a wide variety of interests, affiliations and geographical locations. These expressions of interest took the form of requests for copies of the study's reports, the formal and informal talks to a variety of audiences, for participation and advice in the planning of new projects and offers of schools and school systems as arenas for trial of such pilot programs as might emerge as a consequence of the study.

There were something on the order of 230 requests for reports of the study from individuals other than those who had been involved in either the preparation for or the deliberations for the summer study. In addition, about 100 copies were requested for transmittal to corporations. The individual requests came from 34 states throughout the nation and from nine foreign countries. These reflected the interest of high school teachers, school principals, superintendents of school districts, state colleges, university schools of education, individual university professors, directors of adult education programs, departments of industrial arts and technology, agricultural departments and research groups, as well as state and local public education agencies. Of the 230 summary reports mailed, the table on page xxi indicates the distribution according to the affiliation of the individuals to whom they were sent.

Advice and assistance of the Vocational Education Study staff were sought by six state departments of education, by four divisions of vocational education and two divisions of adult education or employment, four special programs (Southern Manpower Technical Assistance, Overseas Development, Research Council of Major Cities, and Educational Council of Greater Cleveland) and five industries. Of the inquiries from educational institutions, 37 came from universities, 19 from colleges and technical institutes, and 73 from school districts.

In view of the fact that no special effort had been made, either during the summer study or subsequent to it, to publicize what was going on, the number and variety of sources of inquiries makes it clear that not only is there widespread national concern about the problem of education for occupational goals, but that there is a real urgency in many quarters to embark in new directions and develop new programs to help cope with a rapidly growing critical situation. There seems little doubt but that the pressure for rapid action will continue to mount. However, as has been made amply clear throughout the report, the tightly coupled interactions among all the things that must be done concurrently to embark on a meaningful pilot program require adequate time for planning and assembling the necessary resources and facilities. In the long run, more rapid progress will be made by insuring the cohesiveness of all relevant parts of a developmental program rather than rushing into crash programs of a fragmentary nature.

APPENDICES

INTRODUCTION

MOST of the written material produced by the M.I.T. Summer Study appeared during the last two weeks of the session. Each of the five working groups submitted a report summarizing its findings and conclusions, written by or under the direction of the group leader. Subgroups, whose spontaneous generation was so characteristic of the Study, filed their own reports independently. A relatively large number of individuals ultimately put on paper ideas they had been developing during the whole session. The results appeared in some fifty documents. They, together with the discussions during the course of the Study, comprise the raw material from which the findings and recommendations were derived.

Because group membership constantly changed despite continuing interest in the objectives of the individual groups, the authorship of the substance of their final reports is not easily identifiable. Similarly, the members of subgroups ordinarily came from several different task forces, often to address themselves to an aspect of a topic raised by still some other group. Finally, some statements prepared by individuals influenced the thinking of several working parties as well as the sense of the Study as a whole.

What is of importance is not who wrote which report but which of the reports significantly contributed to the ultimate positions taken by the Study as a whole. Every effort was made to insure that each report, whether written by a group, subgroup, or an individual, got a fair hearing before the Study ended. Consequently, the documentary evidence is more properly identified as belonging to the study as a whole than to any segment or member. Therefore, the following documents are organized by title rather than by source and the names of contributors have been removed. Wherever possible, the order has been determined by the substance of the report, with the final, most comprehensive document first. Reports whose contents do not lend themselves to such classification or which support or exemplify an established position have been assigned a separate location.

In addition, each report from whatever source has been edited in an attempt to insure clarity of expression and evenness of style.

GOALS AND STRUCTURE

FINAL GROUP REPORT

THE following principles developed through a discussion of the central question: What *over-all* educational goals and structure can best provide opportunities for *all* youth to develop and achieve suitable vocational objectives?

1. Preparation for useful, gainful, and satisfying occupation or employment should be one of the objectives of the education of all youth.

2. Certain facts, concepts, skills, attitudes, and processes of vocational-occupational education are relevant to all education and should be experienced by pupils at all educational levels.

3. Education should be conceived in terms of an open-ended sequence of goals, and not as a terminal process.

4. Education for specific vocational competence should provide for built-in versatility and flexibility to assure that students acquire understanding, knowledge, and skills that are transferable in a changing technology.

5. Vocational-occupational education should be considered part of the entire process of education and therefore should be concerned with all the capacities of an individual – intellectual, manipulative, social, and creative.

6. Education in school can at best provide only part of the total vocational competence of an individual, shortening and making more effective pre-job and on-the-job education by the employer.

To apply these principles, new or modified educational patterns must be developed. All students in grades seven through twelve should be exposed to several areas of common learnings. These areas would include language skills, computational skills, social studies, science, art, music, literature, physical education and health education, and some vocational learning.

Within the scope of common vocational learnings, facts about materials, processes, devices, vocations and institutions have value and relevance in the lives of all students, and, consequently, should not be restricted to only one group of students. Vocational learnings for all students should include concepts about their environment. The interaction between technology and society, the role of money, and features of business, such as risk and economic security, are applicable to many actual life experiences.

A student's innate abilities should be explored and his capabilities expanded. All students should have some experience in manipulating materials and solving problems. Creativity and social skills are capacities which must also be developed by the process of education. Because people can best be prepared to adjust readily within a changing technology by flexible and expandable patterns of education, the development of all capabilities of each individual is essential.

The result of the application of such processes would stimulate attitudes which are part of the desired ends of any education. The personal satisfaction from accomplishment which can be derived directly from these new experiences may sustain not only vocational interests, but also avocational interests. Diverse knowledge leads to a pluralistic approach to the solutions of problems. Individuals in such circumstances remain flexible in their personal goals. The multiplicity of individual responsibilities and the potential conflict among these responsibilities created by such an educational process would develop the student's flexibility and adaptability.

In grades seven, eight and nine, some of the facts and concepts mentioned above should be introduced into the school experiences of all students on an expanding scale as the students progress. At the seventh-grade level, pupils may study materials related to everyday experience (*e.g.*, wood, paper, textiles, common metals) learning their properties and uses by experimentation and manipulation. The properties would be described in terms of such characteristics as hardness, malleability, electrical and thermal conductivity and solubility in acids. The students would study the availability of the materials in terms of abundance, distribution and synthetic substitutes.

In the eighth grade the list of materials would be expanded, and quantitative measurement would be increasingly emphasized.

In the ninth grade pupils may study materials and properties which are more remote from everyday experience (minerals, plastics, less common metals) while continuing the laboratory and manipulative approach. The properties would be described in quantitative terms involving not only measurement techniques but also mathematical concepts.

But learning about materials is only one approach to take in grades seven through nine: another approach may be found in facts about vocations. In the seventh grade the kinds of jobs considered might be those closest to the pupils' direct experiences.

In the eighth and ninth grades the number and types of job groups are expanded. Pupil experience should include trips to places of business, industry and other job locations and visits of employer representatives to the school. If possible, each pupil should engage in a number of work experiences in shops, offices, laboratories or other potential work stations within the school.

High school education should not be considered terminal for any student. The education of all senior high school students should be directed toward continued education: in apprenticeship, in pre-job and on-the-job education; in post high school occupationally oriented institutions; or in liberal arts colleges, professional colleges, or two-year baccalaureate transfer program of junior colleges. Students may choose from among three types of senior high school programs of which there may be many variations, all of which are flexibly interrelated to allow for crossover. A student must fulfill certain requirements in order to be graduated. Also, some work experience is desirable for all students at some time during the senior high school period.

Although the objectives and programs of all high schools should provide opportunities for the development of vocational competence as well as preparation for formal post high school education, no senior high school should have objectives and/or curricula directed exclusively toward the development of specific vocational competence. In grades ten through twelve the common vocational learnings for all students, regardless of post high school objectives, should be extensions and expansions of those of the lower grades.

The common vocational learnings in grade ten should include information about a number of specific vocations selected to match the vocational needs and aspirations of the students and about the careers available in the local and national economy. Along with expansion of the general study of groups of vocations in grades seven through nine, in grade ten an emphasis would be placed on the requirements for entry into the vocations; on the education and skills needed; on the duties and functions involved; on the conditions and rewards of work; on the variety and sequence of jobs within the vocation; and the opportunities for moving into other vocations and professions.

Grades eleven and twelve would extend the knowledge of facts and concepts involving the relation between technology and various aspects of society, and the relation between risk and economic security. To these studies would be added the study of the role of the entrepreneur and the study of those institutions which affect the nature of work, such as labor unions, business organizations and government agencies.

In addition to the common learnings in grades ten through twelve, there are special learnings for each student appropriate to the objective he has chosen. General vocational skills (*e.g.*, typing, drafting, use of hand tools, use of simple machines, distributive skills, homemaking, business skills) and academic subjects according to his interests and post high school occupational-educational objectives must be carefully selected to provide a broad base of fundamental skills which will allow flexibility and versatility for future change.

The experiences of pupils in learning the facts and concepts mentioned above involve nearly all the traditional subject areas and teachers of grades seven through twelve. Hence, articulated teaching is an important technique in increasing the effectiveness of pupil learning. Another useful technique, which will be described shortly, involves the concept of a shop-laboratory. These special considerations must be studied one-by-one successfully to coordinate each with the others.

Specific parts of the new patterns and structure of the program of vocational education require special consideration. The shop-laboratory, its purposes and characteristics, the function of Research and Development Service Centers, dropouts, improved guidance, the grouping of students and ways of introducing common vocational learnings into the school programs are areas that need particular attention.

The purposes of the shop-laboratory are both specific and broad. This multi-purpose room or complex must operate with a flexible schedule to allow access by individual students or classes as freely as possible. By relating the concepts of subject disciplines to direct manipulative experiences, laboratory work would reinforce classroom experiences and motivate new learning. The laboratory would also provide a place for interaction of pupils of different abilities and backgrounds, for experiences with a variety of vocational skills and activities and for interrelation of teacher activities.

Since the shop-laboratory, as here defined, is more a concept than a physical entity, existing shops and laboratories, with perhaps only few changes and additions, could be used to achieve these purposes. If a new shop-laboratory is to be designed, however, the functions it would serve would benefit by locating it centrally within the school structure. The laboratory should be equipped for experimentation as well as projects, and movable or portable equipment would add to the range and flexibility of possible activities. The specifics for one or more types of shop laboratories as well as kinds of materials (*e.g.*, textbooks, films, film strips, laboratory equipment and exercises) need to be studied and developed in terms of this new program. A teacher with a broad background in the areas served by the shop laboratory should be assigned to provide assistance as needed.

Research and Development Service Centers, organized on a state or regional basis, would be a useful means of providing local school systems with the information needed in planning, operating and evaluating their programs. The functions of this organization would be to carry out surveys, studies and other research on request of school systems, to provide consulting services to school systems for the interpretation and application of research results, and to serve as clearing houses for information on current research and educational developments.

While an educational pattern should not be designed specifically to meet the needs of any special group, it is appropriate, within the overall pattern, to make recommendations for identifiable groups with special needs. If the pattern is to be relevant to *all* students it must reach dropouts. The solution of the problem lies in the development of an educational pattern that is meaningful, useful and desirable to the potential dropout. To create such a program is one intended purpose of the pattern outlined by this and other groups during the conference.

Since the school is only one, albeit strong, influence among many other forces – social, economic, psychological – acting upon a child, the problem cannot be eliminated entirely by the school. However, leadership must be assumed by the school for early identification of potential dropouts, for remedial assistance at early stages, for increased individual attention, and for curriculum revision and other methods which can significantly decrease the magnitude of the problem. There should also be opportunities and encouragement for dropouts to return to formal education. While some opportunities will require the participation of other community institutes and agencies, others, can be offered within school systems.

The role of guidance in the school is particularly pertinent to dropouts. College training programs for guidance counselors would make their efforts more effective if greater emphasis were placed on vocational orientation. The training program, however, is only a base for the guidance counselor's skill. In order to use his skills effectively, he must maintain contact not only with academic but also with vocational and community resources. To augment and strengthen the work of the guidance counselor, new materials and techniques for vocationally oriented guidance should be developed to assist students in identifying appropriate vocational objectives for themselves.

The manner in which students are grouped (interests or abilities) will influence the activity that takes place. To expand whatever limits are established by certain groupings, opportunities should be provided for mingling of different types of students. All students, no matter how grouped, should have experiences in the fields of literature, art and music.

The vocational learnings common to all students may be introduced into school programs in a variety of ways. Group and individual guidance sessions, special units in several subject areas, special courses of study and articulated teaching are only a few suggestions for incorporating these learnings into the program.

Beneath these specific considerations lie basic questions for any program in education. How specialized should the new vocational education program be? Further exploration is necessary to establish proper balance between general education, specific vocational education, and college preparation to accommodate the overlapping roles of each.

The proposed program must gain the support and cooperation of influential community groups and individuals. Ways of involving parents and teachers in the development of educational patterns must be worked out to accomplish the objectives with this necessary support from the community.

The implications of the vocational education program for the physical structure of schools and facilities of grades seven through twelve and post high school educational institutions, the program in kindergarten through sixth grade, the length of the school day and year and possible changes in local, state or federal law must be studied carefully.

The following guidelines are intended for local school systems planning to establish a pattern of education in grades seven through twelve which includes common vocationally oriented experiences for all students and education for vocational competence for some students. Some of the suggested activities, if organized on a continuing basis, may also provide means for evaluation of the programs after they are established.

The planning of patterns of education should be the responsibility of an adequately and competently staffed group which is established and financed for this specific purpose. An accurate cost of the program should be part of the planning to be submitted to the community. In planning such a program, school systems should seek consulting services of state departments of education, other government agencies and universities. School systems should communicate with and visit other communities in which such educational programs are in existence or development. Small school systems should explore the desirability and feasibility of establishing a joint comprehensive high school with other communities.

The planning of certain areas of the program would benefit significantly from information gained by surveys on employment needs and trends in the area of the school, post-high school educational opportunities near the district, estimates of the present and future number of potential students for the programs, certification requirements for teachers, licensing requirements for various vocations, and local and state and federal laws that may affect the development of the program.

Elements of conflict within society will influence the application of the recommendations. The integration of schools, special problems of education in large cities, relation of private and public schools, status and salary of teachers, cultural impoverishment and illiteracy and the amount of money needed for education are factors which may vary among communities. These issues must be understood before implementation begins in a specific area. The relation of adolescents to contemporary society and the contradictions among their biological maturity, their social and cultural restrictions, and their economic needs and opportunities require further consideration in the context of the new program and the ways in which it might resolve these disparities.

For evaluation of the educational pattern, the characteristics desired in a high school graduate must be the major criteria. These characteristics include knowledge and understanding of the nature of the physical environment, the origin and nature of social structures and institutions, the physical, biological, psychological characteristics of human beings and the interactions among people. More specific qualities include fundamental skills in communication, computation and manipulation of things and processes and some degree of skill in a vocational area. The high school graduate should possess knowledge and understanding of the nature of careers, the processes of finding and keeping a job and the variety of occupations from which he may choose. He must have developed the adaptability and capacity to work toward achieving his objectives in a dynamic society.

More basic than the academic and vocational characteristics of the educational pattern is the development in each graduate of the ability and motivation for self learning and continued education. Ideally, he should enter his job with more than a skill and fundamental knowledge of the basic disciplines he should have the ability to think and act rationally and to balance and enjoy the emotional as well as the intellectual, physical and other aspects of life.

Conclusion

Secondary education should not be considered terminal for any student. Grades seven through twelve should provide some common vocational learnings for all students and offer some more sharply oriented vocational education for certain students.

Three types of student objectives have been identified. In order to graduate, each student must satisfy the requirements of a program directed toward one of these types of objectives.

All programs should be flexibly interrelated so that a student may change from one to another depending on his objective. The objectives and programs of all high schools should provide opportunities for the development of vocational competence as well as preparation for formal post high school education.

Research and Development Service Centers

THIS *ad hoc* group came together to analyze and develop the proposal for Research and Development Service Centers made by the group on educational goals and structure.

Service centers, organized on a state or regional basis, would be a useful means of providing local school systems with the information needed in planning, operating, and evaluating their programs. The functions of such centers would include carrying out surveys, studies and other research, on request of school systems. Service centers would provide consulting services to school systems for the interpretation and application of research results and would serve as clearing houses for information on current research and on educational developments.

These functions would be performed to support the distinct *mission* of the service centers as stated by the group on educational goals and structure: to serve school systems in planning, operating, and evaluating programs. These programs are, by definition, new programs, but they have to be at least in the process of development before they can be served. The development of these new programs and the new materials upon which interdisciplinary courses are based must take top priority.

Despite the distinctness of mission and the priority for materials, however, we feel that the functions of research and development service centers cannot be carried out at locations separated from materials development centers. Both materials research and development and development services ought to be carried out at the same place if the planning, operating, and evaluating of new programs are to be relevant in local schools. Their administrators cannot be expected to accept and administer a program in which the content and dynamics are not understood. While school administrators need not be able to teach the new programs, they do need to be able to comprehend how and why the new programs work. Administrators, then, need quick and easy access to the locations where the development of our new programs is taking place. Such access must be geographical and physical; second-hand access by movie or television is not good enough. The provision of direct access is a major service to management in planning, operating, and evaluating new programs.

But this service is not the only one management should have in order to introduce and to serve new educational programs; administrators have special needs of their own. The servicing of these needs is the peculiar function of Research and Development Service Centers.

Therefore, the *function* of such centers should be to provide information to local school administrators on the basis of which they could initiate, operate, and evaluate our new programs. A great deal of this information, all of which is relevant to local schools, and is needed, comes from a variety of sources — national, regional, state, and local.

More than likely such data will not be enough; local districts will need specific local data in order to insure appropriate local planning and to lay the basis for relevant local operation and evaluation. Participating local schools, then, can well be asked to provide data about themselves to be included as part of the basis for participation. Copies of this information ought to be kept by the Service Center for its own research.

The carrying-out of this function, the *operation* of Service Centers, is largely determined by the nature of the information required. The performance of such operations will require not only educators, but the heavy involvement of a wide range of specialists from many scholarly divisions and departments – demographers, sociologists, economists, students of public finance, political scientists, men in public administration, etc. Such expertise must be tapped for help if managerial services are to be supplied in the quality and number which administrators need and to which they are entitled.

One consequence of such services may be the desire of local school districts to change their organization and structure in order to accommodate and serve program changes. Many such revisions will necessarily involve state governments and departments of education, since many aspects of organization and structure are statutory. As a result, some Service Centers could be called upon to work with state education administrators of state school laws. Some relatively specific questions for state educational administration arise:

1. What new programs for vocational education can be reimbursed out of federal vocational education funds?

2. Who will supervise our new vocational education programs and on what basis?

3. Who will administer such programs and through what channels?

4. In view of the amalgamation of educational institutions which our programs imply, does a school – either vocational or college-oriented – have to be a building? Considering the persistent national shortage of classrooms, and especially the virtual non-existence of vocational facilities in junior high schools, mobile vocational laboratory-shops able to service, in succession, a number of junior high schools might expand use of our new programs better than construction of special buildings on fixed sites. Can states transport programs to students rather than students to programs?

Decisions on such questions will necessarily involve the U.S. Office of Education. In addition, demands for national statistics of all sorts, nationwide implications of changes in state plans, requirements for very large scale evaluation and justification of new programs, the necessity of tapping talent of the very highest quality wherever it may be in the nation (or world, for that matter), all combine to suggest the creation of a *national, inter-university, educational management service center.*

What has been involved here is rudimentary analysis of a nation-wide system. Graduate schools of industrial and business management, have had a good deal of experience with this kind of analysis in their own fields. Much work has been done in analysis of our national defense system. Several European countries have had considerable experience with national educational planning. All these efforts may have something to offer us not only in handling materials development, but much more in analyzing and serving state and national educational administrators.

The sum of these suggestions for the organization of Research and Development Service Centers is to begin opening the way for changes in the current external organization and structure of American schools where such changes prove necessary. These proposals can also lay a foundation for the prudent development of new patterns of external organization and structure as direct working experience with new programs indicates the need.

What we suggest, in effect, is offering to local, state, and federal educational administrators the same levels of interest, service, and support which we are so anxious to offer to pupils and teachers in vocational education.

THE "GRAY AREA" STUDENT

FINAL GROUP REPORT

THE group undertook an examination of vocational education with two principal constraints: (a) that this should not be a "library study" and (b) that an emphasis on content quality be maintained. However, there are certain studies, reports and bodies of knowledge, without reference to which our efforts could become exercises in "rediscovering the wheel" from an educational point of view. With this in mind we found it appropriate to draw on such bodies of information to provide a foundation for the efforts of this group.

An examination of the results of our present national educational patterns outlines the following gloomy picture:

1. The net yield of any seventh-grade population examined at the appropriate date for college graduation is only 15%.
2. 35% of all students drop out before completing high school.
3. 40% of all remaining students do not continue their education beyond high school.
4. Of those continuing into the college years, 40% drop out before receiving a baccalaureate degree.

The students typified under 2., 3., and 4., which include 80% to 85% of secondary school students, are, in fact, the "gray area" students.

Against this background of alienation from formal education, the economic system is undergoing an extremely rapid change. There are decreasing opportunities for employment of the unskilled, and skills other than those traditional to vocational education must be made available to those who aspire to employment.

We have identified some of the characteristics of students in the grey area as follows:

1. poor attitude toward education (*i.e.*, the system)
2. a continuous history of failure and under-achievement
3. a sense of rejection by adults and peers
4. poor study habits
5. little sense of personal or group responsibility
6. lack of motivation and direction
7. low level of reading and arithmetic skills
8. lack of knowledge of career areas or vocational possibilities

Enough work has been done to indicate that many children enter our school systems with both an absolute and a comparative disadvantage. A study conducted in the Newton school system demonstrated that within 25 elementary schools, children entering the kindergarten class in any one school varied markedly in their exposure to formal pre-school experience. In some schools 85% or more had experienced one or two years of nursery school. In other schools less than five percent had received such exposure. The work summarized by Benjamin Bloom and his associates in the book *Stability and Change in Human Characteristics* (University of Chicago, 1964) emphasizes the age range three to six as critical in educational development since it is then that educational learning capacity is in its maximum growth period, and thus most easily influenced.

While noting the above phenomena, we can do no more than suggest that an intensive effort be undertaken to improve the quality of elementary education to the end of providing solid learning skills and experiences. We suggest that the "ungraded" concepts of school organization (based upon the continuous progress of each student at his own pace) be tested quite rigorously in an attempt to prevent the problems created by rigid structure, social promotions, inadequate makeup classes and the consequent increasing disparity among pupils' performances. The resulting loss of self-esteem builds frustration that heads many children into the feeling of alienation from the educational process. Since many of the problems seen in the elementary schools spring from cultural attitudes in the children's homes, we suggest that new relationships between the school and other public and private agencies be explored so that early identification and remedial effort on a total scale can rectify inadequacies surrounding the child.

We felt it appropriate to leave the problem of the lower school with these recommendations. While formal education extends beyond the twelfth grade for many pupils, either in terms of the two-year community college or the four-year institution, we believe that the immediate problems of children currently enrolled in grades seven through twelve are of sufficient importance for us to concentrate on that grade range. Unless something is done, these children will be entering the labor market in ever increasing numbers with an ever increasing disparity between the requirements of society and the skills which they have to offer. To attempt drastic modifications of the educational structure on an emergency basis is impossible when the fragmented nature of the educational system of the nation is considered. We therefore determined to present feasible and practical modifications which we believe will require a minimum change of emphasis in the existing patterns to be effected in the short term. However, the effects of every change upon the student must be tested in relation to the following desirable outcomes:

1. Increased student understanding of personal identity (capacity, ability, aspirations and interests)
2. Increased student sense of personal worth
3. Increased student capacity for commitment and involvement
4. Increased student capacity for personal and group responsibility
5. Increased student personal initiative
6. Increased student opportunity to experience *successful* ventures
7. Increased student capacity to understand the the nature of change, choice and risk by recognizing one and making the other
8. Increased student awareness and understanding of the meaningful interrelationship of subject matter and occupations and people.

A prime objective of such a program would be to mold a human being capable of what can be called "purposive action," *i.e.*, the human capacity for creative risk and personal investment within the collaborative context of self-commitment.

Our original purpose was to examine the curriculum now available to the average capable student. We attempted to examine the reasons for what appeared to us to be a non-directed general offering which seemed to prepare the student neither for college (as validated by typical 40-60% college dropout rate) nor the working world (as validated by general lack of any saleable skills).

As a point of departure we concentrated on identifying those characteristics and capacities which seemed to be common requirements for all occupations and leisure activities and which were found to be lacking in the products of our general education program. Some of these characteristics, reworded into criteria and objectives, will be found in the following pages.

As our studies proceeded, we found major contributions and substantial philosophical development presented by other groups in the study. We gradually formed firm opinions about what materials and techniques would be conducive to eliminating negative student traits and reinforcing the positive patterns. When we attempted to plan an organizational and curricular structure for this one group, we discovered we had to plan across the board for all students.

We believe we have suggested a climate for learning which can be created in any school system. Realistically based on sound educational psychology, the program must have a planned interrelated curriculum which is deeply exploratory and experiential for all topics and all students. In effect we have recognized the need for a certain amount of "tracking" or homogeneous grouping while remaining aware that the use of such methods can be detrimental to the student's self-image. We were also concerned with the brutal facts of life faced by any board of education, administrator, or teacher – you must provide financial relief and alternate suggestions any time you revise curriculum and impose new responsibilities. Since the structure is being revised, we have also had to suggest any administrative reorganization which would make the curricular changes possible.

As a basis for the suggested seventh-through-twelfth grade program, our group determined that heterogeneous grouping would be an important objective in the early years, while a more widespread use of homogeneous grouping might be appropriate at a more advanced level. We also decided that grades seven and eight should have general and exploratory aims in the vocational area and that provision must be made for much exploratory manipulative work. Grades nine through ten should begin to afford, along with general exploratory courses, some opportunity to explore special areas of interest in depth. In grades eleven and twelve, more concentrated efforts should be directed at in-depth exploration of skill subjects including the possibility of extensive work-study and vocational subjects within a comprehensive area high school. Such changes as we suggest call for intensive study and examination by teachers and administrators. We therefore will conclude our report with a series of recommendations to implement study of these proposals.

In view of the preceding statements, we are submitting the following suggested program for the seventh through twelfth grades and comments about side issues.

Problem

To provide a ***meaningful, interrelated, functionally-oriented*** curriculum in a comprehensive school with *vocational* directions provided by experience with techniques and materials.

OBJECTIVES	**COMMENTS**
1. Plan a curriculum which will be interrelated to provide meaning to all students.	
2. Plan a curriculum with goals in the broad vocational areas rather than a restricted goal of teaching a specific subject without a function to focus on.	
3. Plan a curriculum which would meet the needs of all students through verbal and non-verbal experiences.	This will be accepted by developing a respect for learning through sensory as well as textbook experiences.
4. Plan a curriculum which will provide *all* students with basic skills, attitudes, knowledges and other tools which will give flexibility and adaptability in a changing world.	
5. Provide a challenging curriculum based on student interests with the view to reinforce positive behavioral patterns and eliminate negative patterns.	This will be accomplished by providing a student with highly motivating materials and techniques which enable personal involvement *e.g.*, learning center, experiential lab systems and topical approaches.
6. Plan a program which will allow maximum intermingling and interaction of students and thus destroy the present-day caste system of tracking.	Such a program must engender in each student total respect for himself and his peers and the dignity and place of all careers.
7. Plan educational experiences and environment in which the nature of all children can best flourish through a framework that questions each youngster's sense of belonging and self-identity.	
8. Provide an open-ended curriculum structure to allow all citizens at anytime to continue their education.	Disbursement of Federal Funds under PL 88-210 and PL 89-10 and other subsequent legislation should be conditional upon state and local education systems meeting this objective. All state financing of vocational education should, when necessary, be modified to meet this objective.

In order for the learning done by students to be meaningful and set in a complete structure involving a normal process of events, various disciplines are to be interrelated in an organized fashion, and teachers are to be made aware of the interrelationships that exist among the various disciplines.

Flexible use of pupil time, assignments and activities based on individual needs, interest, and abilities, and a genuine concern for the progress of each pupil necessitate planning for the grouping of students and teachers in a physical environment that will foster the development of these goals. Our study group has committed itself to multi-age grouping of students, cooperative teaching including team teaching, non-graded vertical organization, and a "Learning Center" as a separate room in close proximity to the members of the teaching team.

This team of teachers, different from team-teaching, will be composed of specialists in the areas of language arts, social science, mathematics, science, guidance, and the "experiential laboratory" areas (industrial arts, home economics, arts and crafts, business education) who will work with heterogeneously organized blocks of 125 pupils. (These blocks of pupils will be referred to as "platoons.") In addition, there will be a resource pool housing remedial reading and mathematics personnel, a trained librarian, fine arts and music specialists, supportive guidance services (school adjustment counselors, psychologists, test administrators, attendance teachers, and social case workers), and health education instructors. The resource pool is to be at the disposal of the team members as the need arises.

The "Learning Center" will house a library and research center supplemented by books and resource materials from the main library in the school, a seminar room for pupils and teacher conferences, industrial arts and home economic equipment, a science laboratory, a business education room, and a creative arts center for music and fine arts. Each platoon will have available to it the larger and more fully equipped facilities included in the basic structure of the school. A full-time "Team Aide" will be assigned to the supervision of the "Learning Center," and a laboratory assistant will help in the preparation of science experiments and audio-visual equipment.

Each team of teachers cooperatively will plan a variety of "thematic" activities involving cooperative group teaching, large-group teaching, and small-group instruction. Initiation of the theme and/or problem may occur during any of the classroom teaching activities planned by the team of teachers. Although individual work by any pupil may occur within the structure of a classroom activity, there are times when this does not appear to be feasible. Therefore, we have the birth of the "Learning Center" as a place for the individual pupil to work alone. Here the student can work at his problem for an extended period of time, leave it for awhile, receive the help of the team aide and/or laboratory assistant, and call upon the skills and talents of all supporting personnel.

Teachers are to be provided with scheduled time for the planning of team and individual activities with other team members and with the pupil members of the platoon. By facilitating the frequency with which teachers can interact with each other and with the pupil members of the platoon, the varied resources of all will become actively involved in the "act of teaching."

When we add the flexible use of pupil time to the flexible scheduling of teachers, "no bells," planned seminar activities, independent study either remedial or for explorations in depth, guides for individual experiences, and both large and small group activities, the catalyst has been provided for purposeful learning.

The ever-growing body of knowledge to be imparted has made the self-contained classroom obsolete. Our current student population demands and must have the combined knowledges and skills of our experts in a laboratory area where individual needs, interests, and abilities can be explored through a series of challenging experiential processes. Time and personnel must be given to the youth of today for the educator to fulfill the demands of a changing society.

The following set of charts and diagrams provide in some practical detail a sample of one way in which our program could be worked out.

GRADES SEVEN AND NINE

(Charts I-A and I-B)

All students will be scheduled with teams of five teachers in the areas of English, mathematics, social science, science, and experiential laboratory. A seven- or eight-period day with forty-minute modules will be average scheduling across the nation.

Heterogeneous groups of 125 students will be assigned each teaching team. Teachers can then plan a "floating" schedule which permits *homogeneous* and *heterogeneous* grouping on alternating days to satisfy both the needs of specific classes and the student need of intermixing with his peers. On the following two pages are a sample procedure and schedule for achieving both objectives.

CHART I-A

SAMPLE OF HOMOGENEOUS AND HETEROGENEOUS GROUPING IN GRADES SEVEN AND NINE

(Sections I through V, the homogeneous groups, meet every other day)

(Sections VI through X, the heterogeneous groups, meet on the alternating days)

Section I	Section II	Section III	Section IV	Section V	
1.	26.	51.	76.	101.	Section VI
2.	27.	52.	77.	102.	
3.	28.	53.	78.	103.	
4.	29.	54.	79.	104.	
5.	30.	55.	80.	105.	
6.	31.	56.	81.	106.	Section VII
7.	32.	57.	82.	107.	
8.	33.	58.	83.	108.	
9.	34.	59.	84.	109.	
10.	35.	60.	85.	110.	
11.	36.	61.	86.	111.	Section VIII
12.	37.	62.	87.	112.	
13.	38.	63.	88.	113.	
14.	39.	64.	89.	114.	
15.	40.	65.	90.	115.	
16.	41.	66.	91.	116.	Section IX
17.	42.	67.	92.	117.	
18.	43.	68.	93.	118.	
19.	44.	69.	94.	119.	
20.	45.	70.	95.	120.	
21.	46.	71.	96.	121.	Section X
22.	47.	72.	97.	122.	
23.	48.	73.	98.	123.	
24.	49.	74.	99.	124.	
25.	50.	75.	100.	125.	

The following schedule (Chart I-B) illustrates how both the homogeneous and heterogeneous groups would meet on a weekly basis. The homogeneous groups, sections I-V, would meet on Monday, Wednesday, and Friday while the heterogeneous groups, sections VI-X, meet on Tuesday and Thursday of that week. The schedule would reverse for the homogeneous and heterogeneous groups every other week. Thus, during the following week, the heterogeneous groups, sections VI-X, would meet on Monday, Wednesday, and Friday while the homogeneous groups, sections I-V, meet on Tuesday and Thursday. For example, during the first week section I would meet only on Monday, Wednesday, and Friday to study English during the first period, lab the second period, science the third, etc. During the second week section I would have the same classes, but meet only on Tuesday and Thursday.

CHART I-B

A TYPICAL PROGRAM FOR 125 STUDENTS IN GRADES SEVEN AND NINE

Homogeneous Groups—Sections I-V meet M-W-F first week T-Th next week
Heterogeneous Groups—Sections VI-X meet T-Th first week M-W-F next week

PERIODS	ENGLISH	MATH	SOC. SCIENCE	SCIENCE	LAB.
1	Section I M-W-F T-Th VI	II M-W-F T-Th VII	III M-W-F T-Th VIII	IV M-W-F T-Th IX	V M-W-F T-Th X
2	II VII	III VIII	IV IX	V X	I VI
3	III VIII	IV IX	V X	I VI	II VII
4	IV IX	V X	I VI	II VII	III VIII
5	V X	I VI	II VII	III VIII	IV IX

Periods 6 and 7 will be devoted to such courses as music, physical education, foreign languages and electives.

CHART II

Seventh, Eighth, Ninth Grade Experiential Lab—Suggested Development

All students heterogeneously grouped will be scheduled into a four-unit rotating subject block. Many blocks should be developed to be chosen or selected by student.

First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Home-Technology (in wood shop)	**Personal Economics**	**Arts—Crafts**	**Services**
Tool safety rules	*Personal Finances*		
Home safety	Purchasing	Sketching	Audio-Visual Projectionists
Small hand tools—*Repair* home furnishings	Consumer Education	Drawing	Duplicating machines
	Furnishing	Painting	
Small power tools—make item for home	Maintaining home	Etching	
	Budget	Engraving	
	Credit	Silk Screening	
		Wood cuts	Cafeteria helpers
Planter boxes—picture frames		Ceramics	Garden maintenance
	Insurance	Plastic	
Work with plaster and cement, paints, woods, design		Photography	
	Group Finances		
Total electrical, plumbing, gas systems with business implications	Operating a business	Weaving	Library assistance
	Profit and loss	Leather	Clerical work
Work with electric appliances			
	Selling	Jewelry	
Work with waxes and detergents, and household dangers such as chemicals	Advertising	Mobiles	
	Designing		
Work with sewing machines, washers, dryers, dishwashers, plumbing, gas, electric, water, repair electric appliances	Merchandising		
	Distribution		
	Costs		
	Manufacturers		
	Credit		
	Packaging		
	Entrepreneurship		

(See next page for a sample systems approach to this section)

SAMPLE SYSTEMS APPROACH OF HOME TECHNOLOGY, SEVEN-NINE

Units may be developed in many areas based on experiences centering in the home. We suggest the following as examples. Each unit should be designed to develop further the content materials of English, social sciences, science, and mathematics, *e.g., 110 v. Home Power System Problem:* How to design creative lighting for student's home recreation room.

ACTION	LOCATION
1. Research Study. Identify simple basic equipment for room lighting in relation to purpose. (Reading area, snack bar area, etc.)	Learning Center (Manufacturers' catalogs; G.E., etc.
2. Write proposal to English and Technology teachers.	Learning Center.
3. Draw free-hand layout sketch from outlets to house main panel.	Learning Center and experiential laboratory.
4. Draw schematic representation of layout from outlets to house main panel.	Experiential laboratory and science room.
5. Cost estimate of project.	Mathematics room, home, etc.
6. Write to electric power company and Building Inspection Department for proper licenses, inspection, etc.	English room (business letters) Learning Center (filing system).
7. Make scale model of room and installation. (Circuiting to panel, switches, break wires outlets.)	Experiential laboratory and Learning Center.
8. Write articles geared to various reader level; *e.g., Better Homes and Gardens,* Newspapers, Technical Journal.	Experiential laboratory, Learning Center, English room.
9. Validating report to class as general contractor. (Oral reporting)	Learning Center (large group reporting), English class (small group).

DIAGRAM I

GRADES SEVEN THROUGH NINE

ENGLISH CONTEXTUAL GRAMMAR ORAL COMPOSITION LITERATURE	200 Minutes/Wk	200	200	All teachers should interrelate subject matter and written assignments; *they can share their time.* Mathematics and science teachers will utilize two period block to interrelate their subjects. A learning center will be provided for each team or pair of teams.
SOCIAL SCIENCE TOPICAL APPROACH CULTURAL GEOGRAPHY WORLD HISTORY	200	200	200	
MATHEMATICS ALGEBRA GEOMETRY	200	200	400	
SCIENCE	200	200		
EXPERIENTIAL LABORATORY	200	200	200	
ELECTIVES	Physical Education and Elective			

This Diagram is based on the following data:

A seven-period day is recommended in forty-minute periods maximum and flexible scheduling of these periods into twenty-minute modules.

125 students, heterogeneously and homogeneously grouped, according to the requirements of the material being studied, and assigned to five teachers on a team.

The objective of each program is to move the student ahead into the next learning level.

DIAGRAM II INDICATES THE FOLLOWING INFORMATION

1. Learning Center should be available to each team for manipulative reinforcement of verbal presentations.
2. Grade ten is a transition into deeper exploration of career skills.
3. We assume adequate motivation deriving from team organization and one or two electives to hold potential dropouts until at least Grade eleven.
4. All teachers should provide information about careers and opportunities pertinent to discipline areas.
5. Associate Arts or Science degrees and Trade-Math-Science block must provide opportunities to explore and construct equipment necessary to demonstrate scientific principles. The lab should be equipped with basic tools, or provision should be made to work in shops when necessary.

AB —AB degree courses
ABD—dropouts from AB-college level but experiential academic orientation grades 10, 11, 12
AA —Associate Arts or Science degrees
T —Trade

GRADE 10 PROGRAM

DIAGRAM II

	10% AB	40% ABD	40% AA	10% T
English	200	200	200	200
Social Science	200	200	200	200
Mathematics	200	200	400 Math Science	400 Period Block in Lab.
Science	200	200		
Physical Education	200	200	200	200
Foreign Language	200	200	Elective	Elective
Elective	200	200	200	200

This schedule is for teaching teams of five with groups of 125 students.

Numbers in blocks indicate minimum minutes per week in each subject area.

Time is accorded for double periods for exploration in shop, arts, homemaking or business education.

Teachers unoccupied during any period will then pick up another class in an elective area or share their time with another team.

GRADES ELEVEN AND TWELVE

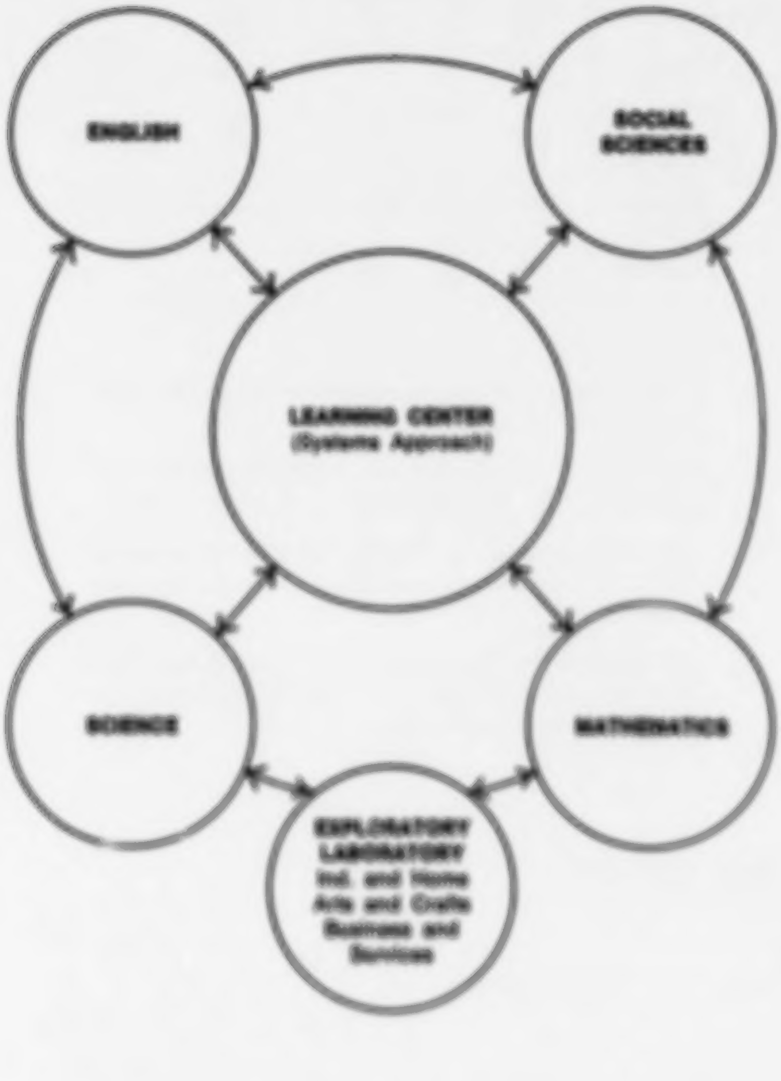
DIAGRAM III

	AB		ABD		AA T
		Pre-Technical	*Pre-Medical*	*Pre-Business*	
English	200	200	200	200	English and Social Studies 200
Mathematics	200	200	200	200	Mathematics and Science 200
Science	200	200	200	200	Physical Education 200
Social Science	200	200	200	200	See 5. below.
Physical Education	200	See 4. below.			
Elective	200				
Elective	200				

1. Grades eleven and twelve provide many possible avenues of general or specific career course work.
2. This program brings vocational education to a comprehensive school.
3. In AB degree courses, group teaching teams are optional.
4. Provision should be made to allow students to move from one area to another as needed, particularly in electives for AB degree course and AB degree course dropout students.
5. The Associate Arts or Science degree and Trade groups would have the alternatives of a work-study program, continued vocational experience or concentrated vocational training.
6. The number 200 refers to the number of minutes per week for each subject.

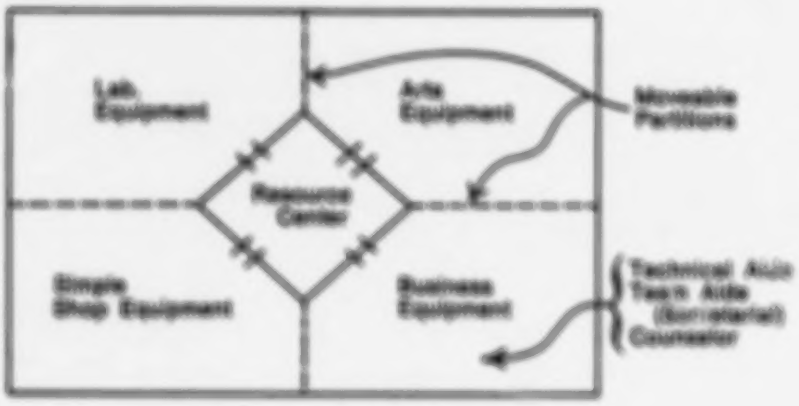
DIAGRAM IV

INTERDISCIPLINARY SYSTEMS APPROACH THROUGH THE LEARNING CENTER


ENGLISH
SOCIAL SCIENCES
LEARNING CENTER
(Systems Approach)
SCIENCE
MATHEMATICS
EXPLORATORY LABORATORY
Ind. and Home
Arts and Crafts
Business and
Services

GRADE SEVEN, EIGHT AND NINE

We have taken a typical grade seven-eight-nine class. We have assigned teams composed of one English, mathematics, science, social science and Lab teacher for each 125 students. Each group of 125 students is of heterogeneous composition loosely chosen in the following proportion. The selection should be balanced with 50% in the top student group and 50% representing the lower ability and/or achievement level group. This group of students is assigned to the teaching team for five periods. The team will group and sub-divide the students in order to teach according to particular needs of different groups. The team will be provided a *Learning Center Room* which they will utilize as they deem necessary, *e.g.*, small hand tools, paints, power drills, saws, camera, and plastics. The room should have facilities to accommodate a minimum of sixty students with an enclosure for private study, conferences and library research.


Lab.
Equipment
Arts
Equipment
Movable
Partitions
Resource
Center
Simple
Shop Equipment
Business
Equipment
Technical Aide
Team Aide
(Secretarial)
Counselor

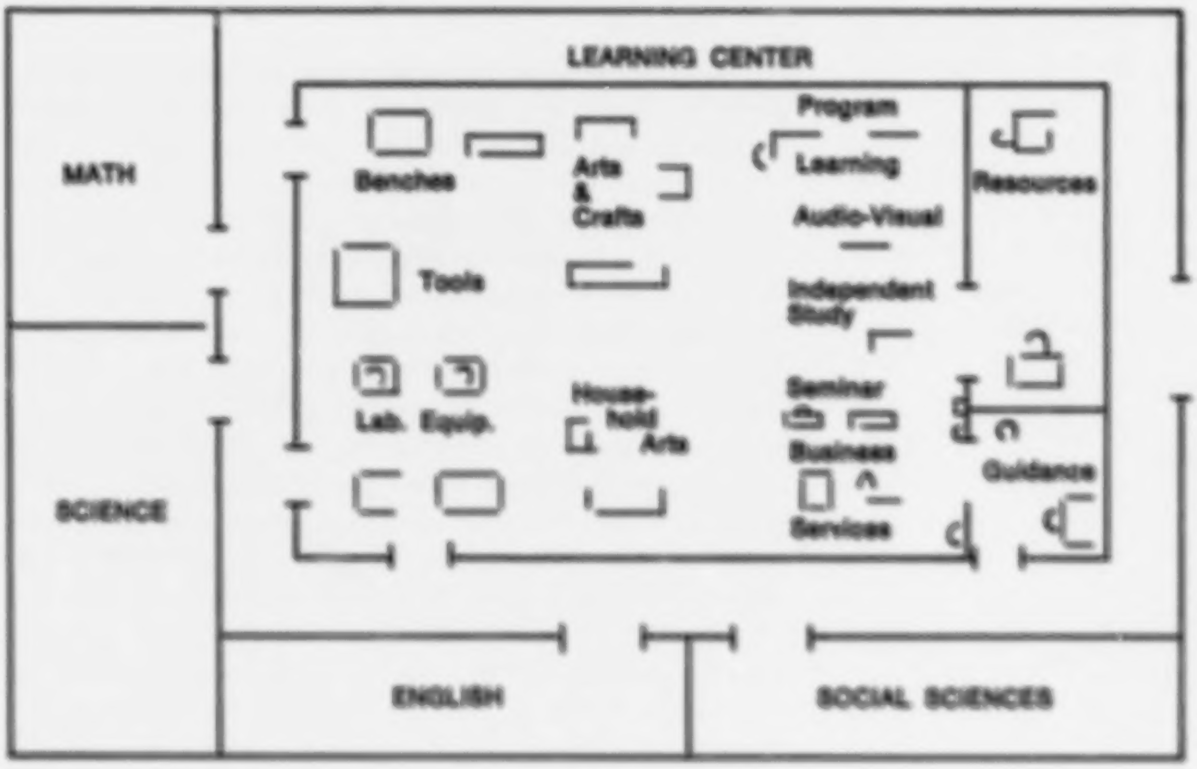
LEARNING CENTER

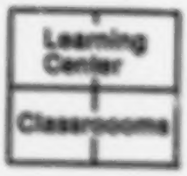
LEARNING CENTER

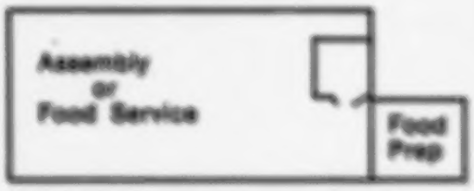
The Learning Center facilitates the systems approach to interdisciplinary team activity involving English, social sciences, mathematics, science and the experiential laboratories.

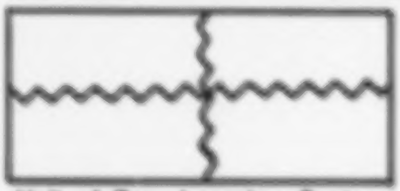
Each Learning Center will include:

5—Teachers
1—Counselor
125—Students-Heterogeneous Group
1—Technician
1—Team Aide (Secretarial)


LEARNING CENTER
MATH
SCIENCE
ENGLISH
SOCIAL SCIENCES
Benches
Tools
Lab. Equip.
Arts & Crafts
House-hold Arts
Program
Learning
Audio-Visual
Independent Study
Seminar
Business
Services
Resources
Guidance


Learning Center
Classrooms


Assembly or Food Service
Food Prep



Unit of Four Learning Centers

Subgroup on Implementation and Dissemination

THIS subgroup was organized to investigate the various problems concerned with implementing the integrated seven-through-twelve curriculum being devised by the rest of the "gray area" study group. The following considerations do not cover the whole range of issues in vocational education, just as the seven-through-twelve program (in the subgroup's opinion) does not answer all of the problems in this range. This subgroup was concerned not only with the smooth operation of the seven-through-twelve program, but also – and more important – with the success of those students passing through it. Therefore, the following requirements cover services and organizations outside the individual school which, when created or improved, will offer greater opportunities to the student *after* completing the seven-through-twelve program as well as before. These remarks are intended as a guide for identification of problems and suggestions for approaching them.

Comments on the Design-Evaluation-Dissemination Sequence in Educational Innovation

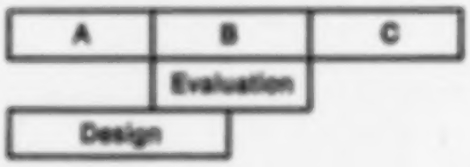
There is some reason to question whether the problems of implementation and dissemination should be investigated within a Study which is primarily searching for "new approaches." Some might assert that such considerations belonged in a later phase of the design-evaluation-dissemination sequence.

It is precisely this linear conception of innovation which has retarded educational progress and which is in sharp, unfavorable contrast to current industrial R&D techniques. The traditional sequence, admittedly oversimplified, is represented below:

1-5 years			1-5 years		time varies
Original Design Group(s)	unforeseen modifications and obsolescence of design material	discussion & controversy	Controlled Evaluation often in biased circumstances	discussion & controversy	Implementation & Dissemination often limited to locale where evaluation took place (or similar)

Consider that the educational lead-time involved in gaining output from a new seven-through-twelve program may range from seven years for mechanics/technicians to more for those students in other kinds of higher education. Add the prerequisite sequence above, and we must conclude that such a sequence is no longer a realistic strategy for educational change.

The major premise of this subgroup is that the traditional sequence must be telescoped as follows:



A + B + C = Dissemination, where

A = Analysis of requirements for successful implementation and dissemination of new program, including techniques for involving ultimate "buyers" in design phase.

B = Political-legal action to prepare ground for widespread institution of new program, once evaluated; information channels to marginal groups during process of evaluation and modification must be developed.

C = Setting the program within State and/or community power structure, providing guidelines for implementation.

The subgroup has been occupied in area "A", from which recommendations have been developed for strategies in areas "B" and "C".

General Recommendations

1. *Coordination with Outside Organizations*

Since the structure of the internal organization is covered in detail elsewhere, we will consider here only the coordination of the internal organization with outside agencies or organizations. The operations of the seven-through-twelve program will be far from self-contained. The success of the program will, to a large degree, depend upon effective relations with state and community groups. Communication with Divisions of Vocational Education, Divisions of Employment Security and Divisions of Apprentice Training, their federal counterparts in a region, industrial groups, local Chambers of Commerce and community action groups is vitally important.

2. *Finances*

The new seven-through-twelve program will be expensive. Since five vocational areas must be included to qualify a school as an "area vocational school" under provisions of the Vocational Education Act of 1963, the costs will approximate those of established noncomprehensive Area Vocational-Technical Schools ($4-6 million). A comprehensive school which could offer the new seven-through-twelve program might not be economically feasible for a student body below 1500; some federal sources place this figure closer to 2000. The range accounts not only for variation in local construction costs but also for different kinds of vocational areas which might be offered. The new seven-through-twelve program would necessitate expensive equipment for any skill-training in depth. Such costs would result in local outlays which are beyond the resources of most districts even in relatively affluent areas. Real estate taxes are at the upper limits of tolerance, and many districts are already undergoing heavy expense in elementary school and/or Area Vocational-Technical building programs. Therefore, careful cost analysis must be undertaken, not only to determine the optimal size of the school, but also the minimum area which it is financially practical to serve.

3. *Current Sources of State and Federal Aid*

These constraints indicate that careful legislative analysis must be undertaken in order to obtain sufficient funds for implementing, continuing, and expanding the program. Guidelines with clear procedures must be set and technical assistance must be made available to the many communities which are unfamiliar with the range of possibilities. The state must also insure that such funding is directed toward problems facing all of the eligible students and/or trainees listed under the Vocational Education Act of 1963. The Elementary and Secondary Education Act of 1965, the Economic Opportunity Act of 1964, the Library Services and Construction Act of 1964, the MDTA as amended in 1963, the National Defense Education Act of 1958, as amended in 1963, Assistance to Federally Affected Areas in the Vocational Education Act of 1963 are only the major legislative sources to be considered.

4. *New State and Federal Aid Programs*

In the case of poorer states, such assistance programs may not suffice; consequently, new aid programs should be recommended. Outright support or tax rebates are among the possible ways for government support to encourage poorer states or regions within states to institute new programs.

5. *Areas Outside the Seven-through-Twelve Program*

With inadequate or stultifying education at the kindergarten through sixth-grade level, a child may not be capable of achieving maximum benefit from the best seven-through-twelve program under the best of circumstances. New programs for pre-school and in-school instruction in kindergarten through sixth grade must be developed to prepare the student to enter the new seven-through-twelve program.

Consideration must be given to special programs for the mentally and physically handicapped who are not included in the seven-through-twelve program as presently designed.

6. *Communication System*

The new program, if it is to remain viable, will be constantly changing. Information channels must be set up within the school, between the school and the state Center, and between the state and the National Center for Educational Statistics. In the latter two cases, the statistics must be supplemented by the establishment of a research clearinghouse. The scope of a multiple-channel information system dictates computerization. Such a system is currently being designed for data from vocational schools. The range of information should be enlarged to include general secondary and post-secondary institutions. Communication between school staffs must be kept open by means of teacher organizations and workshops.

7. *Legal Barriers*

Various legal barriers may hinder the implementation of the new program: legislative "ear-marking" of funds, teacher certification, state-aid formulas, outmoded administrative structures and spheres of authority, and excessive reliance on educational "home rule." The term "legal," in this sense, includes the whole body of administrative law (*e.g.* policy directives) which assumes the force of legislated acts. Administrative changes can be made on a trial basis with full evaluation of the effects of such changes on the program's performance when these effects are identifiable.

8. *Private Schools*

If the dissemination of the new program is to be truly successful, it must benefit all children who are capable of benefiting, wherever they are educated. Since in some localities as much as forty percent of elementary and secondary students are being educated in private or parochial schools, these schools must be allowed to participate in any comprehensive new program, either under provisions of existing laws or under new laws.

9. *Program Promotion*

Educators, with some notable exceptions, have been weak in presenting their new programs to the public. Notwithstanding the admittedly thorny problems of state-church separation, divergent educational aims, use of public tax funds for private purposes and conflicting hierarchies of authority, every effort must be continued to open avenues for participation of private and parochial school children in the occupational parts of the new seven-through-twelve program. Even with the best program and staffing, however, promotion is a crucial phase. Various approaches can be used: Preselling through involvement of the client in the design phase; invitations to administrators and legislators to observe pilot programs in operation; brochures containing understandable comparisons of educational costs with welfare subsidies; identification of the community power structure, especially those who influence the decision makers; and, where conflicting expectations exist among clients, constructing a "truth table" listing points of agreement and possible "trade-off" areas, which indicate proper selling strategy.

Conclusion

Perhaps the three major deterrents to educational innovation (as distinct from invention) are lack of money, lack of an adequately trained teacher supply, and stubborn (if honest) allegiance to outmoded educational patterns and institutions. Teacher education and re-education of the most imaginative kind is therefore a primary requirement. The subgroup has omitted it only because it is being handled by another group. Finally, the problem of what is meant by a "typical" school (urban vs. rural, small urban vs. metropolis) is presently unresolved.

Program Promotion

Any educational program proposed, no matter how well conceived and beneficial, is indeed stillborn if it does not receive both the approval and active support of the entire community. Acceptance of the proposals by school boards and administrators is not enough. Since interest and support is most effectively generated by personal involvement, every member of the community must be made aware of the problem and his or her aid solicited for full and successful implementation.

To reach the general public the techniques used in merchandising and advertising are applicable and effective. This approach should not be categorically downgraded or rejected as grossly materialistic and mercenary, for there exist only effective or ineffective public relations, and the successful implementation of an educational program often depends on the choice made.

The purpose of a public relations campaign is to keep the public continually informed about and interested in the educational programs. Consulting the public in the planning, conducting and financing of effective instruction for children based on the needs of the community is one of the most constructive parts of a campaign.

Public relations should not be an isolated or sporadic effort, but a continuing process. Information must be directed to all people concerned with or affected by the product or institution being promoted. In this case, the interests of manufacturers, industrialists, employers in general, and all users of this educational program should be stimulated. In addition the general public must be kept informed of the benefits derived from an improved educational program. Benefits from improved vocational education can be measured in terms of increased productivity and raised standards of family living. Cost-benefit ratios cannot be effectively established, but they can be rationalized and approximated, for inverse relationships do exist between sound educations (regardless of higher school costs) and welfare roles.

Vocational education is relatively new in secondary school curricula and has suffered from a misunderstanding of its objectives. Because vocational education has not been recognized as a program of useful work to make secondary education more relevant, it has been erroneously linked to the educationally and socially inferior pupil.

The general public is essentially a "mass audience" to be reached through emotional as well as rational appeals. Self-interest too often vies with community interests, and the line of demarcation between the two is sometimes an insurmountable wall. The problem is to get people to understand their present educational setup and the need to revise, expand or reform it without engendering serious conflicts.

There are many ways to approach this mass audience, such as free radio and television time, news coverage and spot announcements on radio and television, through the many public services and through interviews. The newspapers, magazines and trade publications welcome human interest stories, and cartoons and posters are often quite effective.

The domain of public relations, the media of mass communication referred to above, requires applied psychology and motivational and market research as tools to unlock secrets of human behavior which affect the acceptance of a product. One can quarrel only with the purpose for which these tools are used. The stiletto and the surgeon's scalpel are equally sharp and deadly; it is the purpose for which they are used that makes the difference. Advertising psychology and motivational research can be socially beneficial when coupled with projects that enhance community welfare.

Public Relations and the Schools

To illustrate how effective public relations in a school or district can be established and maintained, a typical organizational chart has been prepared as shown herein. The chart is drawn with some detail to show how public relations can be done for any area down to the minimum unit of a single school. Obviously, the chart must be tailored to fit particular needs easily. The salient features of the chart are as follows:

School Administrators – The starting and focal point in establishing relations with the general public must, necessarily, be with the school administrators. Their acceptance and support of an educational program and their willingness to work actively to implement innovations are essential for success. The formation of a public relations committee which will organize and direct such activities should be his first order of business. This public relations committee, composed mainly of faculty members, may or may not need the aid of professional relations people, but some guidance from these professionals should be sought.

Faculty and Students – To obtain the necessary teacher interest, involvement and support, teachers should be invited to participate in formulating and expanding new educational programs. For the teachers, the first and most immediate public is the student; and, through them, the parents and numberless organizations. The faculty has many avenues for action, such as their own teacher organizations, the PTA, libraries and parents. In turn, the parents, once interested, can engage the church, ladies club and other organizations. Communication with the public can be established at various points through a process of multiplication.

Eventual Employers of Student Graduates – Potential users of vocationally trained students should be contacted and made aware of their material interests in schools and their responsibility to the community. Depending on the area affected, the gamut of employers and interested organizations ranges from agriculturalists to foundrymen, from manufacturers to distributors of food and household goods, from chambers of commerce to consumer organizations. The schools should consider the specific needs of these groups and satisfy them. Numberless other groups can be approached, *i.e.*, local women's clubs, social agencies, welfare and Red Cross, all of which represent leavening ingredients that ferment changes.

Lawmakers – Legislators must be kept informed because laws, rules and regulations, as well as the appropriation of funds, rest in their hands. By inviting them to speak at school functions and letting them see for themselves both the achievements and the needs of the school, the legislators will become interested and involved. Further interest can be maintained by sending them letters, reprints, clippings, photographs and reports about the program.

Organized Labor – Since the sanction and confidence of labor is essential if the doors of apprenticeship are to be kept open for students, organized labor should be represented on all committees for trade and industrial education. Vocational educators must give special thought to developing mutual understanding with labor, for unions should be made fully aware that vocational education is not a catchall for misfit students.

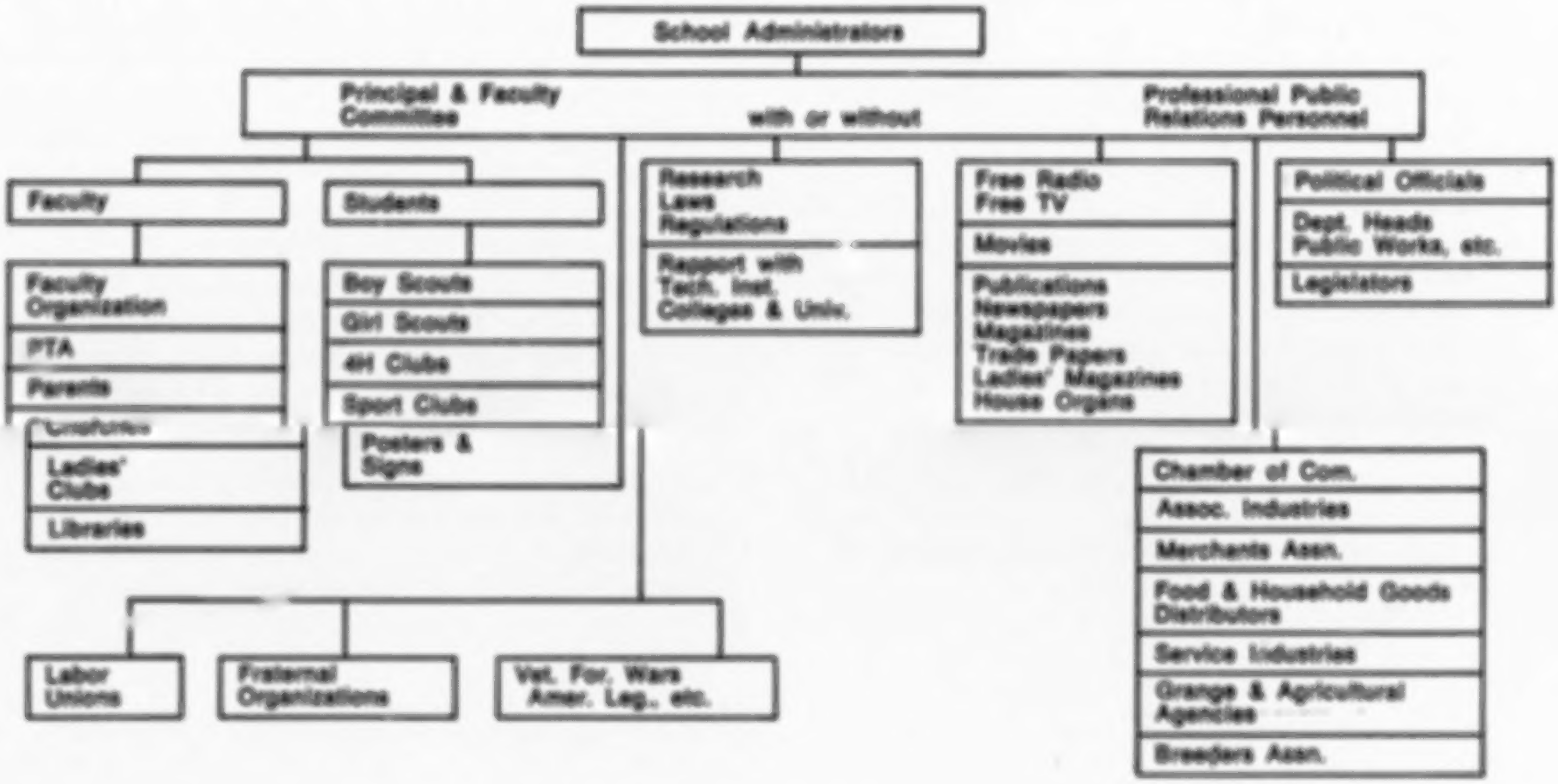
Research Activities – A special group should be gathered to do the task of keeping abreast with current information relating to all facets of education. Government publications, foundation studies, books and all related printed matter should be collected and disseminated to interested and pertinent groups. In turn, this agency should feed back to state and federal levels the innovations tried or contemplated in the schools, statistics and other related data. The function of this group is to act as a terminal for a central clearing house but hopefully not just as a self-contained data collecting and processing unit.

Conclusion – The interplay between the various groups shown on the chart should be apparent. The overlaps should be beneficial, for they represent a unifying and intensifying factor.

A word of caution: contacts with the press should be made through persons knowledgeable in the art of publicity and printing, or else there will be rejection of material submitted and doors will be closed.

TYPICAL PUBLIC RELATIONS CHART

(Applicable to one or more schools)


School Administrators
Principal & Faculty Committee
with or without
Professional Public Relations Personnel
Faculty
Students
Research
Laws
Regulations
Rapport with Tech. Inst. Colleges & Univ.
Free Radio
Free TV
Movies
Publications
Newspapers
Magazines
Trade Papers
Ladies' Magazines
House Organs
Political Officials
Dept. Heads Public Works, etc.
Legislators
Faculty Organization
PTA
Parents
Ladies' Clubs
Libraries
Boy Scouts
Girl Scouts
4H Clubs
Sport Clubs
Posters & Signs
Chamber of Com.
Assoc. Industries
Merchants Assn.
Food & Household Goods Distributors
Service Industries
Grange & Agricultural Agencies
Breeders Assn.
Labor Unions
Fraternal Organizations
Vet. For. Wars Amer. Leg., etc.

Proposal for a Pilot Vocational Education Program at the Junior High School Level

OBJECTIVE: To introduce junior high school students to the broad area of the vocational world.

Method: To interrelate vocational concepts and experiences with the academic disciplines.

Structure: Generally, there may be no change in curricula pattern, but rather, strong emphasis on interdisciplinary action. This emphasis will require the vocational center as the focal point for vocational education, with English, mathematics and science acting in supportive roles to develop learnings and understandings of vocational/occupational areas.

Implementation: Administrators and teacher teams from selected junior high schools meet with "specialists" to: (1) be retrained and develop positive attitudes towards the interdisciplinary approach to education, and (2) develop curriculum.

Critical Issues in Development of a Vocational Education Program

1. What will be different about the curriculum?
2. What are the specific objectives?
3. What will the junior high school product be?
4. What behavioral changes are expected?
5. Will the center be used as an experience library?
6. Can subject disciplines be interrelated so as to give concrete meaning to all subjects for the students?
7. Has provision been made for elementary/junior high school/senior high school teachers to coordinate curriculum development (one administrator and four teachers per school)?
8. Will there be team planning/teaching?
9. Have articulating media – units, field trips, problems – been planned?
10. Is there support for changing teacher attitudes and orientation?

Broad Outcomes

The introduction of an environment must be free and flexible enough to allow administrators, teachers and students to participate in the learning process appropriately.

A. Teachers:
   1. Close working relationships with one another and mutual respect for one another's thinking should develop.
   2. Ideas and techniques which will bring about professional and personal enrichment should be freely exchanged.
   3. A language which will allow constructive communications based on understanding and trust should evolve.

B. Students:
   1. The opportunity for participation of the learners in development of content in the curriculum will be provided.
   2. The feeling that the learner is important and that his mind is an organism which develops and grows would replace the concept of the student as a storage vault for information.
   3. The students would acquire the feeling that help is available from a number of interested people and that learning is not an isolated process but one to which contributions are made by a number of people, involved participants.

C. Administrators: With the involvement of this group who hold key positions in the creation of the environment, an atmosphere conducive to growth will evolve and provide for the necessary fluidity.

Implications of Program on Administrative Structure of Secondary Schools

AN adequate administrative structure to facilitate the interrelated functional teaching approach is a major corollary of our suggested framework. We suggest that due consideration be given the following recommendations.

Each school would divide each grade into heterogenous teams of 125 students, staffed by five teachers who have depth in their own fields. These areas of depth are English, social sciences, mathematics, science, and, in rotation from team to team, industrial arts, home economics, arts and crafts, and the business and service areas. Other subjects are offered as electives, and membership on teams may vary from time to time and from school to school.

The daily program for each team will be worked out by the staff membership of each team. Teams will have opportunity to meet daily during the school day. The only areas that will interrupt the daily routine of teams are physical education, possibly music, and certain electives (*e.g. foreign languages*) that different schools may offer.

Since the team will be a closely knit group to which a guidance counselor will be assigned, emotional and disciplinary problems of students should be matters of great concern to the staff of the team and should have greater chance for positive improvement than ever before. Since only exceptional cases should demand the attention of the administrative office, the principal should be freed of much of the former routine caused by organizational problems and student disciplinary cases. He should be free now to manage instructional support for the school through the team organization.

The Principal. He will be the instructional manager for the school, meeting with the teams weekly, working with individual teachers, and working in support of the team to improve its effectiveness while it is carrying out its professional tasks. The principal is now in a good position to see problems from a variety of angles which will enable him to use his talents to keep each team moving forward smoothly and effectively. He will also be in a position to keep his staff continuously involved with forward-looking innovation.

Assistant Principals. They should help relieve the principal of routine and may assist him in working with some of the teams on instructional matters.

Team Leaders. Someone will have to assume the initiative in each team. Certain members may be designated for this task, or the responsibility may be rotated. Better yet, the leadership may be allowed to evolve with all members of teams being treated as equals in a task to be done.

Teachers. Great responsibility will be demanded of each teacher. Each one is to be well acquainted with his own discipline and how it can be developed as an exciting experience for students. Further, his creative abilities will be called upon to integrate his content area in collaboration with the other members of the interdisciplinary teaching team into a meaningful systems approach to learning. The teacher will need to feel that he can make the content of his subject live for his students through the systems approach, while realizing at the same time that the responsibility for content in his disciplinary area is his within a frame of 125 students. This dual responsibility will call upon considerable sophistication on the part of each staff member.

Leaders Within the Disciplines. Since depth is necessary at the secondary level and a "specialist" from each field is involved in each team, leadership will be necessary to insure that the structure within each disciplinary area is being satisfied. Therefore, there should be school-wide vertical leadership for each content area to assure that the necessary structure within each discipline is being included in the activities of each team. Each teacher, therefore, is in reality a member of an interdisciplinary and a disciplinary team.

Technical Aides. In the Learning Center, considerable independent manipulative experiential activity and group and seminar research activities will be necessary. A person skilled in these activities and knowledgeable in technology will be a necessary aide to teachers in the Learning Center. As flexibility of student grouping and variety of experiential activities within the systems approach increase in scope, aid for directing students not under immediate teacher supervision will be necessary. The Learning Center makes this situation possible and becomes functional when staffed by a Technical Aide. This person might be a teacher trainee, a two-year technical school graduate, or other person who is technically capable and interested in working with children.

This person will manage the audio-visual and self-instructive equipment in the Learning Center.

Team Aide. A person housed in the Learning Center is needed to conduct administrative and secretarial work in order to relieve staff members so that they can guide the learning activities of their students. Since a flexible systems approach, meeting individual needs through individual interests, demands a variety of work materials for the students, such a person must be able to type and duplicate materials to keep the team functioning smoothly. This person will also be responsible for the library research center in the Learning Center and will be in liaison with the school librarian.

Counselors. They will be working members of teams, using their talents to perceive the personal problems of students and help them understand themselves. They will provide a sensitive listener for the students and can guide them in reasoning out their concerns by themselves. They can provide effective feedback to the staff at team meetings as well as keeping the members continually informed on the nature of the students under their cooperative tutelage.

Secretarial Aide (Disciplinary). Each content area will most likely be involved in the production of work that will be restricted to the single discipline. Assistance, to the extent that it is needed, should be made available to each disciplinary (subject) area. The aides may also be involved in certain kinds of routine duties such as simple test correcting.

Administrative Clerk-Secretaries. A sufficient and effective secretarial staff should be under administrative supervision so that the routine tasks involving pupils, personnel, equipment, supplies, and maintenance will function with ease and interfere as little as possible with the time of the principal.

All of these persons are under the supervision of the principal. If all function effectively, the principal will be free to support the instructional staff on implementation of exciting and effective learning. He will work with individual teachers, with disciplinary teams, with interdisciplinary teams, and with all teams as an integrated staff. It will be his task to lead each team to understand that they have a responsibility to nurture and guide the growth of the 125 students within their team. Not one should go unnoticed or unwanted. The principal should lead each team to use its collective talents to make learning a satisfying experience for each member of their heterogeneous group. As part of their attempt to make learning relevant to the students, they should design into the learning experiences many opportunities for learning by doing in the Learning Center and use every opportunity that falls naturally into the activity at hand to impart information about the world of work. The principal now becomes a stage setter, so that the staff under his supervision will learn by their own experience and involvement.

Implications for Guidance — Personal and Vocational

THE team approach, interdisciplinary in nature, the experiential laboratory and the learning center contribute to the kind of milieu that guidance people can work in most effectively. The inherent characteristics and consequent operation of this program create an almost ideal atmosphere for guidance. The counselor's part as an integral member of the team should be emphasized, because he functions in a different way from the traditional counselor. He will no longer sit in his little cubby-hole, meeting students on a fixed schedule, writing programs and being looked upon by teachers as someone removed from the mainstream of things; rather he will spend a great deal of time where the action is.

No longer isolated, he will be a member of a particular team of five teachers to whom have been assigned approximately 125 heterogeneously selected students. This assignment in itself will be a major revolution by comparison to present counseling loads of 400 and 500. The ratio may be too unrealistic, but even if he were assigned to two teaching teams, the counselor would have only 250 counselees. Regardless of the number of students assigned to a counselor, we can examine his function as a member of a junior high school team and then as a member of a senior high school team.

First of all, the counselor must accept the philosophy that in the instructional arch the teacher is the keystone and that he (the counselor) is the resource person with whom the teacher can discuss a student or to whom students may be referred for help.

The team of teachers handling the same group of students will find that in their group discussion, analysis, and evaluation of student behavior they will be performing a guidance function. In actuality, they will become teaching counselors. This expansion of the teacher's role is the second principle that the counselor will have to accept – he no longer is the *only* counselor. There will be five other teacher-counselors.

In conjunction with this way of operation must be an understanding of the value of self-referral on the part of the student. The client who recognizes a problem and seeks help has already taken the first step toward the solution of his problem. However, the counselor must be considered a helping person with a warm, permissive, empathetic attitude in order for self-referral to take place. By placing the counselor in the team, he would certainly be more accessible and in a better position to create a friendly relationship with students and teachers than he was in a remote office.

As a member of the team, the counselor will sit in on all team conferences listening to the team members discuss their problems and plans. This will also provide him with the opportunity to get well acquainted with a group of five or six instructors instead of nodding to sixty to seventy. Because he can see the program from another vantage point, he will find himself actually engaged in assisting curriculum changes. He will be expected now and then to participate in group discussions while the teacher takes on another group for special work. This situation will provide an excellent opportunity for the counselor to counsel groups and for the students to get acquainted with him. By his active participation in the teaching program and direct observation of students in the classroom and laboratory, he will gain more insight into student behavior than is now possible.

Examination of how the counselor would function in this plan at the junior high school level will afford the opportunity to see how these principles of counseling would work. The learning center is of prime importance to the counselor, for he can operate best in this area. We will assume that he is starting with a team of five teachers with a new group of 125 entering seventh graders. One of the first things he will do (not during the first week, but early in the second) will be to have teachers administer a sociogram. This procedure would have already been discussed in a team conference. The purpose would be to see if there are any students who need the help of the counselor. The next step is to have the team discuss these youngsters and, on the basis of their discussion, outline some special efforts to help them. Since these students seldom come in for help, a certain amount of structuring will be necessary. Here the help of all the team comes into play, for they can easily arrange for these students to be sent to the learning center to work on some project. Since the counselor is a member of the team and has already been introduced as such, and since he now has the time, it is quite logical that he could be in the learning center at the same time as the student. The counselor will find it quite easy to break the ice and offer help on the project. No direct questions need be asked. He will begin to help the student even if at first he only shows him where the tools are or how to operate a machine. There should be natural acceptance by the student since the counselor knows what is going on in all the classes. Within a few days it should be an easy matter to suggest "Wouldn't you like to drop into my office and let me know how you are making out with this project?" This approach will work well with the recalcitrant youth. During all this time the counselor will be meeting with the team to offer suggestions and to note what progress is being made to help these students make good adjustments.

Since this would be the first time many students have been exposed to team teaching because much instruction is done with small groups, the counselor will often be in the position to take a small group and have a discussion and answer time. As a member of the team, he will be competent to handle the discussion and able to answer questions concerning school problems which trouble the student. The important point is that under this plan a counselor is right in the main stream with the students and teachers.

This new position of the counselor does not mean that he doesn't do any of the other so-called traditional tasks. Certainly he will continue to give and interpret tests for students, parents and teachers. While he will also continue to make certain program changes and write programs, much of this work would be minimized by all members of the team participating in these areas. Most changes will actually be initiated while the necessary paper work to carry them through can be handled by a clerk.

By the beginning of the second semester, the counselor should be well established and able to spend more time on individual referrals in his office. However, he would continue to meet in team conferences and to collect data and materials for occupational guidance. Much of this material (audio-visual, pamphlets, etc.) would be used in nine-week units in the experiential laboratory to give students a growing awareness of the world of work and the many opportunities that exist in all fields. Since interests and attitudes of seventh graders are changing constantly, at no time would emphasis be placed on prerequisites or detailed courses of study. The experiential laboratory's main purpose is not only to make learning relevant but also to explore new fields of work. These experiences can fit directly into programs of studies, and the counselor can help students relate their newly-found interests to their school work and to the world about them.

In summary, the important points about the counselor's function in the new program are:

(1) He is not the only counselor, and acts as the resource person in the field of guidance for a team of teacher-counselors.

(2) In the instructional arch the team teacher is the keystone, and the counselor is a contributing part of the team.

(3) The concept of self-referral on the part of the student is the best approach to counseling, and the team approach with the counselor as a member is the best means by which self-referral can be initiated.

Counseling Activities by Grade Level

(Hopefully, the counselor will have the same group of students through to the ninth grade.)

Seventh Grade

Orientation to the new school structure and team teaching would be carried out by the counselor through conferences with individuals or small groups. The counselor should begin exploration of vocational and occupational goals by presenting films, slides, and other audio-visual material. Visits to selected industries to show areas of work should be initiated in the seventh grade to place emphasis not on specialization but on broad experiences. Photography can be used on these visits, for students can take pictures showing an operation or a person at work. This can be followed up with a tape made in the English class to be played with the film or slide. Prior to the proposed visit, but in conjunction with it, the study of photography could be introduced in the science course. Following such a confrontation or possibly throughout the year at intervals the counselor should administer sociograms and tests in aptitude to find out the students' level of aspiration.

Eighth Grade

More intensive counseling about choice of subjects should take place as the students are now approaching their first year of high school. The counselor should hold group conferences with parents to discuss high school programs.

At this time, the formation of small student groups to discuss specific occupational areas such as industrial work, medical fields, business and science would be worthwhile. The visits to local industries should be continued with the use of films, pictures and tapes; and a written report on a specific field of work might be a purposeful addition.

Ninth Grade

Many students at this time begin to think of college. At this level *all* students should be encouraged to go on to post high school education. Interest tests, although their validity is seriously questioned, may be helpful as a device to motivate the student to look into various fields of occupations.

Outside speakers (particularly former students who have graduated from the same school) should be brought to the school. One good technique is to visit the person on the job and take pictures of him at work. Then invite him to talk to the classes while the slides are presented. This kind of talk requires careful preparation, but if well done, a tape can be made while the speaker is describing what he is doing in the picture. The result then becomes a part of the vocational-occupational library of the school.

Both small and large group discussions can be carried on about college and technical schools' admission policies, job qualifications, apprenticeships and the present day labor market. Emphasis should be placed on the need for an education that will help people adapt to the changing employment picture and the need for an education that will allow flexibility of choice.

Tenth, Eleventh, and Twelfth Grades

Since many students will be entering senior high school from a junior high school which has established the philosophy of self-referral, the high school counselor will have far less indoctrination to do. However, a number of students may not have been so influenced, and the counselor, still a member of a team, would use the approach suggested in the orientation program for the seventh grade.

In the tenth grade the potential dropout is particularly noticeable. Although previous work by teachers especially trained for this program should be able to lower the incidence of dropouts, there will still be some who fall into this category. With these students the counselor will be involved in both the work-experience and work-study programs. Again, this plan requires the team approach. The teachers may have to adjust their work for a particular student so that he may remain in school part of the time.

The counselor will arrange for the many excellent films on specific jobs to be run before and after school and during lunch period with many repeated showings. The counselor will also arrange for small groups of students to spend a day working with people on the job. (The chemical industries in California have suggested this.) Many business, professional, and trade people are more than willing to cooperate with the schools, and the best time for this activity would probably be in the eleventh and twelfth grades.

In the eleventh and twelfth years the student should be exposed to all kinds of vocations. Again, the best example of any given type of work can be made by recent graduates who are succeeding in their chosen fields. For example, a cosmetologist could be brought in to demonstrate in several homemaking classes both her training and her wares. The same procedure could be followed for a welder, a lawyer, or a worker in any other field. It would be impossible to cover all jobs, but certainly one should find representatives from the service occupations, industry, trade, and the distributive education areas.

Conclusions

The counselor's job entails many other activities. He must arrange for or administer various tests (PSAT, Merit Exams, College Boards, Apprenticeship Exams), dispense information on the armed forces, and plan career days. The professional literature is filled with many occupational and vocational ideas, projects and counseling techniques. No attempt will be made here to define all the duties and responsibilities of the counselor. Any good counseling text will define these duties and responsibilities and suggest the methods (eclectic, directive or non-directive) which the counselor may employ in his relationship with students. Such a text may also provide useful information about welfare, medical, and psychiatric services for the students.

The counselor, regardless of the extent and variety of his responsibilities, can do a better job in all his duties when he is not a person alone and outside of the classroom but a member of a professional team able to offer his talents and proficiencies as a part of the process of education. This team approach is efficient and psychologically sound in meeting the needs of individual students.

Specific Recommendations

1. The maximum number of students assigned as a counseling load with the teaching team should be 250 students, but 125 would be preferable.

2. As qualification for the job, a requirement should be included for some experience in the following two areas:

   a. Work-study program in an inner-city community center for deprived youth.

   b. Work-study program in which the counselor had as broad an experience as possible in industry. This experience should encompass the entire spectrum of work, from pick-and-shovel to personnel management to time spent with union officials in management.

3. The counselor should receive in-service training in team teaching schools, and at least three hours of course study on the basic principles underlying the team-teaching approach should be included in his curriculum.

4. The counselor and all people involved in a team approach should discuss the ways in which each can perceive the students' concerns with greater sensitivity.

Industrial Arts For All Grades, Seven Through Twelve

INDUSTRIAL arts is instructional shop work which provides for all youth sound educational experiences that contribute to the satisfaction of their purposes, needs and wants. These experiences should be an integral part of the general education program of all youth. Through experiential laboratories, industrial arts offer those learning experiences which assist boys and girls to understand the industrial and technical aspects of life today. This curriculum area makes a realistic contribution to education as a process and shares with other areas of the school the responsibility for promoting the continuing development of the good citizen.

The study of industrial arts, encompassing materials, tools, processes, design, products, and social and economic problems of industry, will enrich the general education of each individual. Schools should offer this area of work to all levels from kindergarten through junior and senior high school, college, and adult programs.

The manipulation and investigation of artifacts for the purpose of discovering concepts of science has been overlooked in education until recently. Now, this teaching procedure is beginning to take center stage in our schools. This conference would like to have vocational shops, for instance, promote the studying of science and mechanics on a practical and applied basis.

We should try to help pupils become familiar with the industrial world in which they live. Students must work with two- and three-dimensional materials, for manual and manipulative learning are as important as mental and textbook learning. Balancing these two elements of learning should also be the concern of teachers of science, social studies, mathematics, language arts, homemaking, business, music, art, and all other areas. Industrial arts offer practical and useful experiences for all students through the experiential laboratory, and in the upper levels (tenth, eleventh, twelfth grades) as well. It may contribute to prevocational as well as vocational objectives.

Pupils should be encouraged to acquaint themselves with the changing nature of industrial occupations and to choose relevant and fruitful exploratory experiences as a basis for intelligent self-guidance. Teachers who inject the student with the "white collar virus" are certain to negate the efforts of the program. The active cooperation of teachers of other disciplines (particularly in the language arts and social studies) is requisite to this objective.

Through the experiential laboratory, pupils would learn to appreciate the aesthetic qualities of industrial products and learn to utilize them to enrich their lives. This clearly makes imperative the cooperation of all teachers, particularly the arts, homemaking, physical education, language arts, and music.

With some knowledge of the qualities of industrial products, pupils should acquire a sound foundation for wise consumer buying not only of present industrial products but also of new products likely to confront the consumer as a result of industrial changes. Reciprocal interest among the teachers from all subject areas would again be necessary.

Students should be encouraged to develop numerous and varied hobby skills in the realm of materials, processes, tools, design, and products. Hobby interests are a legitimate concern of teachers of all disciplines. As a by-product of this activity, pupils might acquire numerous and varied practical abilities in everyday affairs, such as caring for the family automobile, replacing fuses, and repairing electrical appliances. In addition, pupils would learn how to avoid accidents through safe use of gas, oils, detergents, electricity, automobiles, bicycles, and whatever industrial products they may use.

The kind of exploration of materials done in the scientific experiment seems to exclude and discourage the basic understanding derived from direct tactile and kinesthetic experiences through the handling and forming of materials. The student should get the feel of the materials by hand first and later from hand to tool to material. This concept does not mean simply lifting a block of wood or a piece of metal, but rather working these materials in a way that makes a real difference in the student's idea of what they are in relation to himself. A primary identity with the mass, texture, rigidity and form of the material as a whole could be grasped through these experiences with more understanding than through analysis in which the aspects are isolated and related to general concepts. The satisfaction of arriving at these concepts reawakens and confirms the students' curiosity and interest in the feel of things and working from that to creating. The experience of direct contact and exploration for the sake of the senses is profoundly different from that of data-collecting, calculating and concept-forming which is emphasized in science.

As the experiential shop continues through grades seven, eight, and nine, one additional factor will span science and materials — skills and techniques. In the shop situation this new approach to teaching fundamentale raises the practical question, "How do you use tools and machines to produce the goods?" In a new program, the skills and techniques are to serve a purpose and do not become the purpose.

The experiences stated above cannot be separated. Nevertheless, for clarification, the shop section of the experiential laboratory should be attacked on the following fronts (all may be approached within the context of team teaching and should be clearly seen by the student to be part of a large supporting system initiated by the team):

1. Applied science and mechanics.
2. Direct tactile and visual exploration of materials.
3. Skills and techniques as they apply.

Major functions:

1. General education for all (boys and girls).
2. Guidance and exploration for many.
3. Prevocational and vocational for some.

Problems to overcome in making industrial arts available to all:

1. Objectives must be restated to allow for each of the three major functions.

2. Facilities and equipment must be available for such diverse functions (experiential lab, Learning Center).

3. More attention must be given to curriculum development.

4. Conflicts in present philosophy and practice must be resolved to allow for the major functions above.

5. There must evolve a unified system of industrial education to close the gaps in the present assortment of programs.

6. There must be acceptance of industrial arts credit for college entrance.

7. The experiential lab must be required through the tenth grade if it is to serve its first and major function of education for all.

A Sample Activity for Grade Eight

CONSUMER ability to judge intelligently manufactured articles and materials is an important part of personal economy.

However, important educational outcomes from experience structured around working with products are possible. This kind of activity can serve to stimulate students to ask, design, build and investigate.

It is suggested that this activity be one of "problem solving." In this way it becomes a joint venture between a teacher and a group of students. The students play the role of a team of technicians with teachers as consultants. Generally, selection of problems would reflect student interest. The needs and interests of the students would be served by allowing this pupil centered approach. However, the educational rewards depend critically on the teachers.

Upon selection of a problem, those involved directly should experience work, failures, successes, learning and fun.

As an example of the sort of activity that would be suitable for the grade range seven through twelve, the following is presented:

Properties of thermal insulating materials

Centers of interest:

Does insulation work?
How does insulation work?
What are the best kinds?
Why does insulation work?

Preconditions of learning:

Grade 8 class

After visiting a construction site where insulation was being installed, a few boys may display curiosity about insulation, while others in the class may be interested in other things, such as the holding power of nails, strength of wood joints, durability of paint, or comparative strength of various methods of boarding.

Probable and expected outcomes

Skill development derived from:

Planning and improvising test apparatus.
Making a bill of materials needed.

Laying out the stock (size-shape etc.)

Use of tools – scale, square, saw, plane, hammer, glue and clamps, drills, screwdriver, wiring, etc., assembly of apparatus.

Some understanding of the following can ensue:

The function of insulation in reducing the flow of heat through the walls and roofs of buildings, ovens, refrigerators, etc.

Heat flow and temperature difference.

The practical aspects and economics of the use of currently available materials.

The role of insulators as retardants to the spread of fire in a structure.

Communication skills that are involved:

Use of the students' own working drawings.

Use of drawings from various resource materials.

Working in a group on a common problem.

Correspondence to manufacturers, etc., for technical data.

Library research for information on the subject.

Personal contacts with science teachers, and others.

Contacts with local heating men.

Problems to be stated (hopefully) by students:

What criteria must be developed to evaluate the effectiveness of various kinds of insulation?

How can the relevant properties of the materials be measured effectively?

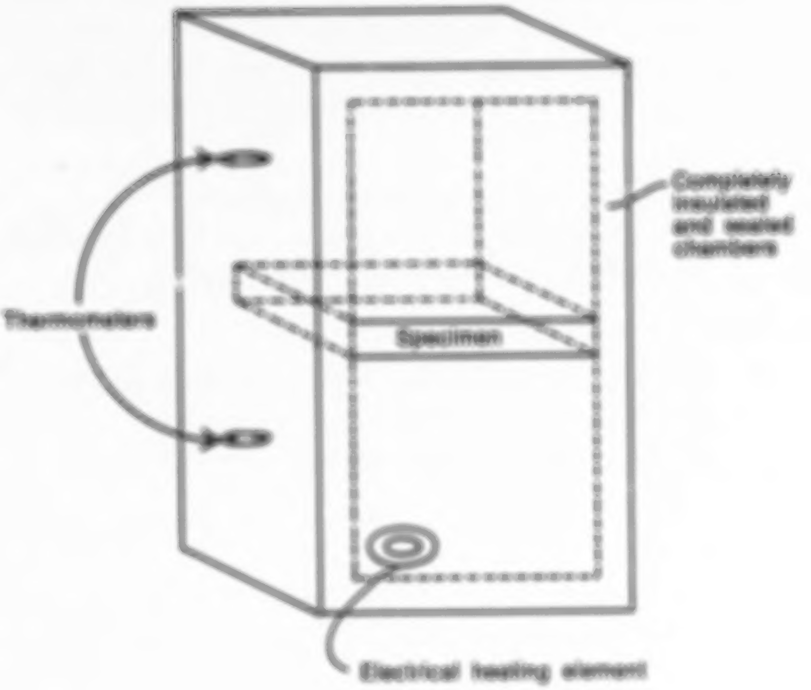
What apparatus has to be built to accomplish this task?

What kinds and brands of insulating materials are available on the market? (Flexible, bat, loose fill, rigid, reflective)

The "technical team" may give a report to the class on their findings. Charts and graphs should be used to convey the results along with a verbal presentation.

Along with the specific data, some general conclusions should be part of the outcome, such as:

SUGGESTED APPARATUS


Completely insulated and sealed chambers
Thermometers
Specimen
Electrical heating element

1. Motionless air is a poor conductor of heat. Thus, many good insulators form tiny pockets of air that are motionless. However, the presence of moisture will change the behavior of the pockets. If heavy paper is used to form a moisture barrier, vapor coming through a wall will condense on a cold surface if it is not protected.

2. Reflective insulation works on the principle that shiny surfaces reflect much of the radiation (heat) incident on it.

3. Among the characteristics of a good insulating installation are: Insulation of low thermal conductivity, use of vapor barriers when needed, fire and moisture resistant properties.

Implications of The Proposed Program For The Area of Business Education

BUSINESS education courses have traditionally been offered in the high school for the purpose of providing boys and girls with a saleable skill. Changes in our economy, our business methods and procedures, and our concept of education demand a change in the role of business education to meet the challenges of modern living.

Within the context of the curriculum suggested by this group and with the aim of achieving the objectives of this program, some changes for business education are: Business education encompasses much more than training for a specific skill, for it has value for all students regardless of their ultimate vocational aim. Basic business information should be offered to all pupils starting with the seventh grade and continue along with a work-study experience which should be part of the education of all secondary school pupils. Certain tools of business education should be introduced at an early level; *e.g.*, the typewriter, duplicating equipment, adding machine. These could be introduced in the elementary school and remain available to all pupils in succeeding school years.

In addition to the fulfillment of the general objectives of the entire program, some of the specific results which could be expected of the business education area are as follows:

Pupils will be more highly motivated in all subjects when allowed, encouraged, and directed to relate all learning in a functional application to problem situations. Those pupils who will be making an early vocational choice will have some basis upon which to make this decision. Mutual respect for all levels of jobs is likely to develop when all pupils have an opportunity to share experiences in all areas. A work-study program will give every child a better understanding of the nature of careers and of business functions in today's economy. All pupils will be better equipped to handle the complexities of the business aspects of their lives. Those pupils who will eventually be business proprietors (a large number of whom do not continue their formal schooling beyond the high school) will be better equipped for this role. Pupils will have an opportunity to study and explore the marketing and distributive occupations which are major job areas. Understanding the total business complex, workers will be better able to move from one kind of job into another.

What changes in the business education structure will be necessary in order to achieve the basic objectives of this program?

In order to determine what units of work would be most valuable and suitable for all pupils in the seventh, eighth, and ninth grade experiential laboratory, the total business education curriculum must be reviewed with an eye to the demands of the business environment upon the individual.

Seventh Grade

The emphasis should be on personal finance with units of work that would lead to an understanding of personal money management and would offer an opportunity to explore banking services, budgeting, credit, and insurance.

Eighth Grade

The emphasis should be on organizing a business with units of work that would lead pupils to some understanding of business management and offer an opportunity to probe such areas as selling, advertising, merchandising, and manufacturing.

Ninth Grade

The emphasis should be on businesses in the local community with units of work that would lead to an understanding of their development and growth and offer an opportunity to explore practices in manufacturing, distribution, marketing, record keeping, etc. This study could well lead to the development of case studies by the pupils.

Inherent in this scheme is the belief that pupils should learn by actual experience. The best way to learn about banking, for instance, might be for the pupils to organize and run a bank or a credit union. The best way to learn about some of the problems of running a business could well be for the pupils to organize a business to manufacture and sell a product.

At the high school level, new courses should be developed in entrepreneurship and business management, particularly in view of the fact that one out of every seven employed persons is *self*-employed. New courses should be developed in the distributive occupations to take into account the growing intricacies of manufacturing, marketing, distribution and selling of both goods and services.

New methods of teaching must be developed for the business-skill subjects that will permit pupils to learn at an individual rate and proceed at whatever pace their abilities allow. The learning center must be utilized fully so that pupils will be learning from experience with specific problem situations.

Since business learnings relate to every other subject area of the school as well as to the out-of-school experiences of the child, courses should take advantage of this relationship to bring all learning into focus for the pupil as part of his total environment.

Necessary to the success of the proposed program is a qualified, competent business teacher. The program that has been suggested creates a number of challenges to business educators. They must learn to work in teams not only within their own subject area but also with all other subject areas. Since business teachers generally are not accustomed to working at the seventh- and eighth-grade levels, retraining of teachers will have to take place in order to orient them. Possibly, business teachers should be prepared to work with children at every grade level (1-12) in order to plan and direct the business experiences of the child and tie them into a meaningful whole. Business teachers must accept the challenge of developing new and exciting materials for every grade level. They must conceive of business education as a joint school and business venture and be willing to experiment with new media for learning. Any preconceived notions concerning the suitability of certain materials at certain grade levels must be abandoned.

Pupils should have an opportunity to use various business machines as the need for these tools arises naturally during the exploratory phases. The introduction of machines at an early level must be planned so that they are part of a total, integrated experience. The pupil must not undergo a series of isolated experiences. Every experience is part of a pattern within the business curriculum and relates clearly to as many other subject areas as possible. No attempt should be made at this level to train pupils on these machines for a "vocational" skill.

Assuming that such business education should be part of the experience of every pupil at the seventh-, eighth-, and ninth-grade levels, business courses will of necessity have to be vastly different at the tenth-, eleventh-, and twelfth-grade levels. Suitable materials must be prepared for use at the seventh-through-ninth-grade levels, and suitable courses must be planned for the tenth-through-twelfth-grade levels into which pupils can move for more specialized business training.

Business educators must enlist the support and cooperation of the businessmen in the community. A work-study program must be developed that will allow every pupil to experience work as part of his high school education. The work-study program can take place in and/or out of the school during the school year or during the summer. The amount of time spent in such a program should be flexible to allow those students who can benefit from a continuing work program to participate in one throughout the year. Other students might spend only two or three weeks in such a program. The constant supervision of the work-study program by the school is vitally important to insure that the work experiences will be worthwhile to the student and that the student worker will not be exploited by the businessman.

Such liaison should offer advantages to the student, businessman and teacher. When the resources of business are utilized fully by the school, pupils will find a ready-made business laboratory at their doorstep and will emerge with an understanding of business that the classroom alone cannot give. Business will have an opportunity to participate in the ongoing educational process, and, at the same time, business educators will be able to make their teaching more vital and relevant.

Recommendations for Business Education

1. Work units should be planned for the experiential laboratory at the seventh, eighth, and ninth grades to provide basic business information necessary for each pupil to meet effectively the demands of the business environment.
2. New courses and new content for old courses should be developed at the secondary level that will meet the demands of a changing business technology and the realities of employment (including self-employment) trends.
3. All pupils should be encouraged to use the tools of business in the handling of problems in all areas.
4. Research should be conducted in the area of typewriting in an effort to determine whether or not it would be beneficial to teach this skill to all elementary school children as a communication tool.
5. As an outgrowth of the work experiences provided in the experiential laboratory in grades seven, eight, and nine, a work-study program should be developed that will continue to provide as many pupils as possible with a relevant work experience at the secondary level.
6. An advisory council of businessmen should be established in every community to work with the business education specialists in the schools.

7. Business teachers should be prepared to be competent in modern business technology and to be able to work in teams. These teachers must be knowledgeable about the interrelationships of subject matter and, at all times, cognizant of the role that business can play in the education process. Business teachers should be willing to experiment with new curricula and methods and always remain sensitive to changing business patterns and their effect upon business education.

Distributive Education in a Vocationally-Oriented Program

AN excerpt from a 1960 publication by the Distributive Education Branch of the Office of Education may illuminate the scope of this area of education:

> "Distributive education is a program. It focuses directly on the distributive personnel within the framework of their careers. It has responsibility at all levels of performance and should be ready to provide organized occupational training whenever and wherever the need is recognized. It is no longer feasible to think of distributive education as a high school course, or a miscellaneous series of adult instructional meetings. As a program it encompasses continuing, organized occupational training pointed toward the broad career objectives of those entering the field of distribution; the more specialized objectives of those who have narrowed their goals; and the problem-solving objectives of those at high levels of distributive management."

The majority of current distributive education programs require students to be placed in a job immediately upon enrollment in the program.

The new educational concepts being presented at this conference illuminate the great need for changes in these programs. An experiential laboratory, starting in the seventh grade, allows a preparatory period during which students have an opportunity to learn marketing and distribution prior to placement in a work-training experience.

Through a study of all that lies between the producer and the consumer, students would discover the functions of distribution, marketing and advertising as crucial parts of a larger process. Packaging, transportation, warehousing, buyers and display are just a few of the areas of work involved in selling products. Investigation of this whole process from end to end could open broad ways into the field of economics and parts of the field of government. Within this process, moreover, there are clear – and growing – opportunities for a wide variety of useful careers.

Recommendations

An experiential laboratory for grades seven through nine should be designed to achieve the following purposes:

a. To enable the student to appraise his abilities, interests, and attitudes.

b. To interpret the vocationally relevant, salable skills needed in areas of employment.

c. To explore the career possibilities in distribution, including salary scales and the magnitude of job opportunities.

d. To study the factors that have contributed to the growth pattern in the number of people engaged in distribution from 15% in 1920 to 60% in 1960.

e. To develop student awareness of the role of distribution in the modern economic structure.

The distributive education curriculum in grades ten through twelve (elective) should be developed to include the following:

a. Grade ten – Preparatory course in job orientation for the wholesale, retail and service industries, to emphasize the educational needs through high school and beyond to attain occupational goals.

b. Grade eleven – Basic skill competence required in beginning distributive jobs.

c. Grade twelve – Functional knowledge of the special areas of distribution.

Areas of Home Economics with Vocational Education Potential

Grades seven through ten would deal with importance of knowledge of:

- Foods and Foods Equipment
- Clothing—Design, Construction, Fabrics, Sewing Techniques, Use of Machines, Millinery
- Interior Decoration and Home Furnishings
- Maintenance and Janitorial
- Importance of those areas to:
  - the individual
  - the world of work
  - the community and its economy
  - national international culture

Team Teaching

To show interactions with:

- Science
- Geography
- English
- Mathematics
- Social Science
- Art and Foreign language

Team teaching members should be acquainted with all career opportunities in the service industries related to home economics.

Laboratory Facilities

Should have the following:

- Home Economics laboratory*
- School Cafeteria
- Field trips in community

* Foods laboratory should be scheduled two periods, in connection with lunch period.

Project Examples

Foods Project—Planning and preparing a simple menu:

- Home Economics and Science involvement:
  - Nutrition and health
  - Origin and marketing of foods
  - Equipment use
  - Preparation and service of foods
  - Sanitation and safety factors
- Mathematics Involvement:
  - Weights and measures
  - Budget available for menu
  - Purchasing of foods
  - Comparison of foods costs—prepared, canned, frozen, and raw
  - Cost per unit of food
- English Involvement:
  - Food Terminology
  - Use of telephone
  - Reading (information on packages—formula and following of instructions)
  - Reference readings
- (Could also involve)
  - History of foods—relationship to cultural subjects, etc.
  - Foods of different nations, markets
  - Foods in industries—*i.e.*, air travel, hospitals, hotels, restaurants, industrial, etc.
  - Agriculture

Clothing Project—Construction of a simple dress. This would teach:

- Construction skills through tailoring
- Principles of color and design
- Creativity
- Basic techniques of pattern drafting
- Origin of fabrics (Animal, Plant, Synthetic)

Projects for Interior Decoration and Home Furnishings, and Maintenance and Janitorial would be developed along the same lines as the foods and clothing areas.

Grades eleven through twelve would include a more detailed understanding of the industry and its opportunities as well as the development of skills required.

- Actual involvement and association of
  - Types of jobs and their requirements
  - Sanitation and safety
  - Food preparation (commercial)
  - Purchasing of foods
  - Nutrition
  - Menumaking
  - Importance of industry to the community and nation
  - Economy—Society—Health
  - Personal hygiene, Courtesy, Ethics
  - Physics and Chemistry
  - Merchandising of foods
  - Building—Construction, layout, equipment and engineering

- English Involvement
  - Industrial terminology
  - Reading and following instructions or formulae
  - The library and its use
  - Reference reading and report writing
  - Telephone usage
  - Verbal reporting and public speaking
  - Letter writing
  - Salesmanship
- Business and Math
  - Weights and measures
  - Applied mathematics—Cost controls, record keeping, payroll deductions, purchasing and formula cost, personal income and budgeting
  - Typing
  - Business organization and ethics
  - Taxation—applied to personal life and business
  - Legal aspects of work
  - Labor unions, contracts

Facilities

Homemaking Laboratory
School Cafeteria and Kitchen
Planned Industry Tours
Business Department Laboratory
Community itself—gas and electric company, city hall

I recommend that a national clearing center, such as the Council on Hotel, Restaurant and Institutional Education or the U.S. Office of Education, issue a bibliography which is geared to teachers and students and revised annually.

All members of the teaching team should participate in a continuing workshop designed to keep them informed of the nature of careers in the commercial foods and service fields and the various techniques of teaching these occupational subjects. Such a workshop would suggest and advise the team members about how to apply their course content to this occupational field. The workshop will serve to introduce the members of the teaching team to advisory committees and set up guidelines about how to work with them most advantageously. The workshop must continue to acquaint the teaching team with the resources of reference materials and educational experiences along with informing them about placement procedures and coordination.

The scheduling of Home Economics Laboratory, faculty dining room, and school cafeteria facilities can be made according to the best interest of the students, school and community. For example, the eleventh grade might use a home economics laboratory during the first semester. For the second semester one half of the class would rotate through cafeteria stations (two weeks on a station) while the other half discusses theory of their cafeteria work. First semester of Grade Twelve might continue the schedule for second semester of eleventh grade. The second semester of grade twelve might include for example, work experience in industry or advanced courses in business education.

The teachers should be familiar with post high school educational opportunities. Information about community colleges and technical programs, adult education programs, short courses available through industry and extension, correspondence courses, available scholarships and awards, and on-the-job training and apprentice programs should be easily obtained by any interested students.

DESIGN

FINAL GROUP REPORT

EVEN in the relatively short time of this conference, the large interdisciplinary groups have reached a reliable consensus and have indicated the directions in which further study may profitably go. Our comments are intended to take their place in the consensus, hopefully to strengthen and focus the many contributions of the other groups and committees.

We have brought our resources to bear not upon a consideration of vocational education as practiced, or as something participated in by someone else, but upon our own experiences, knowledge and view of the practical world and our present convictions about education. Since not all of what should be done can be accomplished in six weeks, we put forward only tentative recommendations with the belief that further study is vital.

Art and Aesthetics in Education

Art, with a broader definition than is commonly given the word, is a basic concept in our approach to education. Today the word art often means long-haired artiness, and connotes to many people a foggy, anti-social form of idealism. We mean art as the essence of culture and civilization — as a way of life aimed toward excellence.

We should develop in our children an awareness and appreciation of aesthetics. They must be taught to apply the creative urge to authentic values or else the inertia of their world will reduce them to blind robots. Education must expose them to more permanent values than the material ones they may have already discovered in order for them to aspire to something better, something higher. What they do in school must be meaningful outside of it and apply to their working and leisure hours.

Through the increasing anonymity of the job, so often considered a nondescript way to earn a living, monotony becomes characteristic of our contemporary way of life. Any change in our educational system must be concerned with preparing people for more satisfying careers whether it earns them a living or provides constructive enjoyment of leisure time. As we move into a world where leisure will become extremely important, we have legitimately to fear repetition of the historical decline of great civilizations through degraded leisure crumbling into boredom, fear and intellectualism. Education must aim toward continuing progress in civilization without limiting the notion of progress to only a super technological order of the new world. For instance, with our technology we can do many complicated things very easily, but one thing we cannot do with technology is decide the important things to do. The values developed through education are crucial in this context. What do we mean by progress? Are we satisfied with our way of living? Are we steadily drifting away from the original idea of America and of Occidental culture? These questions stimulated relevant discussion of the ultimate aims of education.

A Discussion of Education

"What pattern of education will best prepare American youth for satisfying, useful and gainful work at the termination of the period of formal schooling?" This question led us to an examination of schools as they are at present. We saw in our schools the superimposition of two images: First, they reflect our practical world as we see it; and second, they reflect our world as we would have it better. Both images are blurred, the former by rationalization and the latter by wishful thinking and pride. The impressions are thought to be accurate simply because we and our institutions are subject to the same distortions.

The types of each image are currently institutionalized by calling them "vocational" and "academic" and subclassifying them as if the types were valid. Bridging the gaps between these two different types of education is the commitment to provide the best advantages within our means for our children as preparation for their participation in all aspects of life, their leisure as well as their work.

This commitment to and concern about the education of our children is evident in the unbroken effort from the Smith Hughes Act of 1917 to the M.I.T. summer study on vocational education of 1965. The strength and flexibility inherent in a vocationally-oriented program remain, but the image of such an education is no longer accurate. The connotations that have accrued to the concept of "vocational" are now misleading and work against any effort to improve the level of education.

Along with the narrowing of goals explicit in vocational education, many factory operations have tended toward uniformity. Since our making and using is increasingly machine-factured rather than manu-factured, the tradition of excellence has lagged as the care of the craftsman for his material and for the product he shapes has been obscured by the intervention of technology.

Without direct experience with his material and tools, the worker does not develop a sense of excellence. The "mismatch between man and machine," which is currently thought to be the root of many conflicts within our society, is a delusion. The alienation between man and material is the more basic problem and a resolution should be regarded as an important responsibility of education.

This alienation reflects the position of vocational education today. The teachers and students are disadvantaged, and artificially so, by the separation of the act of doing (the skill being taught) and the more important knowledge about the material upon which the skill is being performed. The synthesis of these two processes provides the necessary connection between man and material which is lacking in a curriculum designed to develop specialized skills.

In the course of our study we have had excellent examples of teaching and the uses to which our wealth of technology can be put provided that first the material be studied. As in this study, to learn about the material we must seek information from a variety of sources. People from industry, craftsmen, service repairmen, all can contribute their knowledge of the practical world to the improvement of vocational education.

The approach should not be one of teaching how to adapt ourselves to technological change but rather learning how to adapt technological changes to ourselves. This approach implies the basic question of who shall be the master and the answer is self-evident. The continuity and stability of man within the constant diversity of his natural environment is basic to all societies and should be exploited—not minimized—by present circumstances.

The traditional gaps between cultures and classes offer another immediate challenge to education. These gaps must be bridged in order to provide a strong foundation of knowledge for all students. The scientist and the humanist, and the farmer and the white-collar worker each have contributions which should be utilized to benefit the other. This kind of integration of the work of different men should find its roots in education.

As an outgrowth of this invisible but authoritative line between the men working with their hands and the white-collar men, an artificial structure of education evolves. Not going through college or dropping out of school is an unequivocal disgrace. Consequently 65% of American youth list college as their principal objective. Given a choice for their children, parents choose the profession of teacher second only to medicine. The artificiality of this extreme value on security and social prestige forces those who might succeed in another realm to compete in a world for which they are not suited and from which they receive no satisfaction. Clearly a broader scope of education would allow each person a wider range of goals which would enable him to direct his own interests and abilities toward a useful, satisfying career without regard to the arbitrary and often decisive pressure upon him. Hopefully, the student would have a more sound basis for his decision were he allowed to pursue a more individual goal.

Thought Into Form: A Synthesis

We learn only partly through the analytic experience of the study of facts. By fact we mean all that is independent from man's will or manipulation. Fact includes not only the natural environment, the ecology, in which we live and which constitutes the microclimate of a culture but also the individual character of every human being which makes him a unique person.

But education must go beyond the study of facts to include all that is affected by the development and progress of man. All that we can make, create, use, and all that characterizes time and culture we shall call artifacts. The values of our culture are expressed by the forms we decide to give them. Education should cultivate and develop attitudes toward design and form, both aesthetic and functional, which generate in the student an awareness of the multiple solutions to any specific problem. The student must learn to reassess every problem in the context of contemporary methods and materials and those anticipated in the future.

Art in its broader sense is the common denominator of all the operations in the making of artifacts. Material is given a form through the general process of information which cannot take place without the simultaneous operations involved in design, technique, science, economy and critique. Art can be considered basic to all these operations, because it determines the amount of each process which shall influence the final form of a product. Art as the element of choice, diagnosis and balance which prevents overloading any of the elemental operations at the expense of another, is intrinsic to the pursuit of excellence. The pursuit of excellence and the contingent processes of synthesis in addition to analysis are basic objectives of the new educational program.

Any artifact results from the sequence of two processes – the educational process (to learn) and the vocational process (to apply learning). For instance, through sawing wood, one learns about a tool and its corresponding materials; and by learning and applying processing methods and skills one learns to put the wood into a form such as a chair, framing or sculpture. This information process, the materialization of thought into form, is realized through the synthesis of knowledge about materials, knowledge of related disciplines such as mathematics, and the function or purpose of the thing to be created.

Art, as we have defined it, starts with the honest use of tools and materials. First the limits of a tool and its corresponding material must be understood. The creative act results from the intercourse of a tool and a material. An artifact, such as a violin, is a passive and uncreative object until the bow, its active tool, is applied to create music. The duality implied by this process of creating a form, which then has its own unity, is only one example of the function of synthesis we have explored.

Basic creative tools and corresponding materials, such as chalk and slate, clay tools and clay, or charcoal and paper, are the immediate vehicles of creative thought. Since their work may be instantly erased and redesigned, the process can follow the rhythm of thought through trial and error and constant self-criticism. This close relation between the synthesis of tool and material into the creation offers a direct and intense learning of the way to handle basic tools which is independent from its user and governed by its nature. The complete understanding of this process and its elements is necessary as a foundation for the more sophisticated operations which put man at a distance from the material.

A School Schema

A school, in its physical context and as an architectural concept, is an example of a sophisticated artifact. Each element of the school is organized into a chain of combinations articulated according to a pattern which our schema tries to represent. These elements are the workshops, which may be studio, machine shop or practice room for music; and the study, which may take the physical space of a classroom, a seminar or a carrel. The elements are few, but they are repeatedly integrated into a rhythmic pattern of constant proportion and spatial distribution. The form (architecture) of the school is the direct result of the analysis of its material (learning) and the synthesizing pattern of design, technique, science, economy with the balance of critique.

A decisive distribution of open spaces of varied proportion and buildings takes shape. Art, or the art of living, becomes the main concourse of all paths between all aspects of learning. The scheme includes the shape of a withdrawn garden for meditation, conversation and relation of human experience which we see carried through the great archetypes of all schools: Agora, Forum, Piazza, Quadrangle. In this space the presence of water, gardens designed by man, works of art freely displayed in a living environment of trees, flowers and rocks bring to the mind both ingredients for thought: quietude and excitement.

The library, for instance, is implemented with outdoor carrels and garden areas open and sheltered, where literature takes another dimension. The auditorium, a workshop for critique, is completed with outdoor stage areas, exhibitions and the immediate presence of the people in town or at work, still learning although out of school.

Agriculture, and its far reaches in nature – forests, meadows, mountains, sea and streams – ideally should be part of the school and line it with a belt of activated fields and orchards. Such a pattern creates freedom and tolerance. The relation of academia to the surrounding work of the community becomes closer and an interchange between these ways of life would hopefully evolve.

The school is a complete organism which, for being, needs a close relation with all of the elements of nature rather than an isolation from them.

Recommendations

Consideration should be given to art to regain the value of this aspect of man's activities and, more importantly, to show its place in all of man's activities.

A study of the occupational areas of our contemporary world should be undertaken. These areas are distinguished by autonomy of overall structure. Very few specialized operational tasks are particular. These occupational areas appear to be the following: government, education, finance, manufacture, information, religion, medicine, transportation.

Further exploration of design is essential. We talk about it but have no common understanding of it.

"General Studies" must be developed in an operational manner to remedy the present division of courses which is often artificial and arbitrary.

A study must be pursued *in situ* in a "disadvantaged" school to learn what is there considered important.

To perpetuate learning the teacher must be first a learner. Greater freedom in the general scheduling of teachers to accommodate their learning outside the classroom would inevitably improve their ability and approach inside the classroom. Full-time teachers should be given one half-day of class work and the other half free for personal research, practice and learning to encourage their role as continual learners. All teachers would avoid complacency and static programs by holding temporary exchange assignments in another school. In addition, leaves of absence for temporary stay in industry or personal research would be granted to teachers to support their efforts while teaching.

Design Group - Progress Report

July 9, 1965

THE intent of this study is to create new patterns of education, not overthrow the positive aspects of our present educational programs. The problems as we understand them are:

(1) To fill the gap between vocational education and college.

(2) To investigate pre-vocational lévels with the goals of reducing the number of dropouts, decreasing unemployment, reducing and eliminating the need for retraining unemployed adults and improving the public image of vocational education.

For each member of our group, which was composed of professionals from diverse fields, design had a different meaning. To clarify our objective we asked the question: "What do we want the student to learn?"

Unprejudiced thought, the development of manual skills, verbal skills, social attitudes, creativity and evidence of an awareness of space and time were determined as the fundamental objectives of education. The teacher, as the agency through which these goals are accomplished, must encourage spontaneous classroom situations which prompt pupils to think creatively. Such situations might involve both manual and verbal skills.

Since much of what we learn is obtained through the senses – balance, sight, hearing, taste, smell and touch – they must be developed, not neglected, in the pursuit of the stated goals.

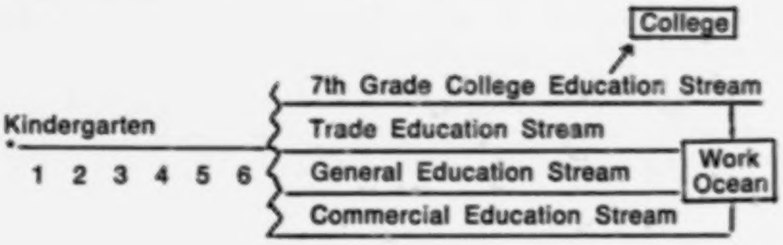
Our major concern was how to induce student creativity, and our goal was to provide the basis for an educational program of fundamental student experiences which would generate student creativity and develop imagination. Getting students to think, to work out new solutions and not merely memorize or repeat, became a central idea from which much of our discussion grew.

Suggested experiences which might help the student begin to create forms and understand the structural limits of materials were building clay columns, piling bricks to the height of self-fracture and working with paper in specific shapes and design. The real purpose of these experiences is design. The child must be made aware of the importance of design in life from the shape of a bird's nest to the line of an atomic submarine. He must be made to grasp the inner logic which underlies any authentic design and which is the only cue to progress and culture.

Design in its basic search for authentic values is the essential means for awakening the child's mind to the world in which he lives and for learning how to shape the environment of the world of tomorrow. History, for instance, is usually taught as a series of dates, battles, treaties and a chronological calendar of facts, birthdays and tombstones. If we focus the study of history around the artifacts (architecture, tools, machines and customs) of the evolution of humanity, we can learn areas of knowledge from many disciplines related in an historical context. History is the design of people, animals and things during a certain definite space of time. In the same way, geography becomes part of the broad study of earth sciences, from astrophysics to atomic science.

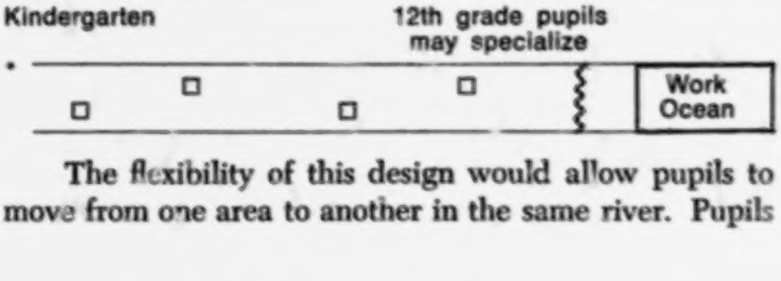
To achieve this relationship between a variety of disciplines in practice requires the consideration of the design of education. In addition to a closer relationship of the various disciplines, we are convinced that a new design of education must employ a unified curriculum structure. We developed a very basic new design for education which we believe to be a definite improvement over our present one.

PRESENT DESIGN



The divisions of the present design have the disadvantages of a decision about the pupil's future being forced at the seventh-grade level and the near impossibility of changing from one program to another if the student changes his objectives. The inflexibility of this design encourages dropouts, increases unemployment, creates the need for retraining and gives vocational education a poor image.

NEW DESIGN PATTERN



The flexibility of this design would allow pupils to move from one area to another in the same river. Pupils would not have to decide about their future plans at an early time. All pupils would be required to take certain courses in common which narrow the gaps between various aspects of their education. Pupils approaching a trade in the senior year would be offered the opportunity of attending a thirteenth and fourteenth year of school to develop that trade experience. This design of education would better equip each student with the manual and verbal skills and social attitudes needed to enter the work ocean.

Arts and Crafts and Music Creative Workshop

GRADES SEVEN, EIGHT AND NINE

ART expression, like all creative activity, builds on self-confidence and grows through self-determined and challenging aims. The concern of this discussion is grades seven, eight and nine; but it is hoped that the student has been encouraged to the end of grade six to express himself creatively in various art media so that he has become sensitive to problems of both materials and form. The term "self-expression" implies a flexibility, independence and self-discipline which develop in relation to a child's mental growth. To encourage self-expression a teacher must treat each child as an individual while being aware that in mental growth (*i.e.*, concept development, reasoning, symbolization with all its sensory and emotional implications and imagination) there are stages of development which in each child must be respected. If a child is treated at a stage other than his own, he will not show real understanding but will become imitative and stereotyped, and wait to be directed. In educating through art, teachers have a special chance to tell whether a child is really using his own resources since all the work being done should be characteristically individual. Materials should be introduced in a way that the student can first explore their potentialities, then give a form to the materials in his own way, individual in its statement, but consistent with the nature of the material.

It is proposed that a nine-week arts and crafts program be initiated for the seventh, eighth and ninth grades. Each class would have twenty students and meet for fifty minutes a day. The class size and period length will allow work to be done and will provide for the interaction among students so necessary in a stimulating discipline like art. The art activities, of course, should not be limited to this workshop period, for a creative shop program will have activities of an artistic nature at some time. The experience laboratory will most certainly have activities in which perhaps all the children will elect to use art materials objectively to approach and integrate some experiences they have had. In the laboratory, students will want to make costumes, decoration, scenery for plays, models for social studies or science, and display material such as posters.

The activities for these grade levels must be planned to encourage continued growth in artistic expression, while at the same time keeping each child's confidence in his individual style. The activities can be programmed to reinforce each other during the three-year period. Of course, many activities must be based on life drawing. Drawing of living things, for both the visually-minded and the inner-oriented children, is a real challenge because drawing a living, moving thing needs (in the gesture, mass and contour elements) both kinds of orientation.

Drawing is an endless cycle of recognition, refinement, and control. But other activities are mechanically sequential. For example, in print-making the materials, techniques, and actual products can be so articulated that a very high standard can be achieved without forcing. The handling of clay is another material which can benefit from planned cyclic treatment. And, of course, technique in painting builds through working with brushes and paint.

The themes should, of course, make use of the student's natural interests – from their bodies, their moods and their attitudes, to skills, clothing, people, animals, places in the world, and professions or occupations. Drawing from life would become important and be intrinsically motivated. Development of such a theme creates its own feedback, for the many roots of art are stimulated.

There are some who want to see the art program prepare people for science drawing and mechanical drafting. The diagramming of ideas should be cultivated in children from the time they are young, and if they are encouraged, they will find ways of efficient abstraction or sign-making which will serve the communicative end in science drawing. Drawing animals of all kinds can be done in the art room. Occasionally these drawings can be correlated with specific work going on at some time or another during the school day; but no correlation should be forced. Moreover, if the artistic roots have been well nurtured, the science drawings can become meaningful in their way as adult medical drawings, or as Audubon's birds, which always reflect with knowledge and feeling both the ecology and the materials (pencil, pen, ink, water colors, and paper, that he is using. Science specialists will benefit from having broad understandings in the arts as will art specialists benefit from having a wide range of experience.

The approach to actual art activities can be either from the materials side or from the side of ideas, themes, symbols and feelings about them. Of course, we can have knowledge and feeling about materials and they should be promoted through stimulating explorations. We understand materials in terms of our sensory experience, or we can increase them, decrease them, reform them, extend them, articulate them or construct with them. As the years go by the student can re-explore and extend his understanding of materials. This understanding will, as with the scientist, grow as the student actually works with them.

The graphic and plastic arts should not be kept in a vacuum and, of course, the children should be helped to find the elements of art in many forms. Sometimes they will discover exciting analogies. Music as a motivation for mood or pattern-making is based on such interplay.

When developing a music program for grades seven, eight and nine, it is important to look at the two major aspects of the art: First, appreciation and performance; and secondly, composition. The order of the evolution of these activities must, of course, be the other way around, but for various reasons, good and bad, the schools have concerned themselves almost exclusively with the former as if it had an intrinsic claim to priority.

Appreciation and performance are ways of extending the horizons of students by familiarizing them with our rich musical heritage, and of deepening their cultural roots by nurturing in them both the joy of singing and the ability to listen responsively with discernment. Since performance in school is almost entirely a group activity, the students learn the discipline of form — how each part serves the effectiveness of the whole. The schools have often exhibited much success in this part of their program.

Further values to be attached to this aspect of the music program came from its providing a rich source of correlated experiences in many areas of the curriculum, *e.g.*, history, literature, creative language, creative dance as a part of physical education, and graphic arts where music may be used as a motivational device.

While music can, of course, reflect historical periods, and can demonstrate the reaction of people to their social and physical world, it is more important — since our purpose is educational — that it can so involve a student in listening and responding that he comprehends the value of a musical experience as an end in itself. Such an experience is the result of creative perception and can be made accessible to students, providing the bridges to appreciation are built skillfully. For music to become part of our lives, it must not be isolated; the student must feel music as a real medium of expression and communication. We must therefore adapt any program to the past experience of the students. Both teaching and learning can then be a creative process.

Creativity then is not limited to composition but should be present in both appreciation and performance activities. Students can share in the actual selection, interpretation, and arranging of a piece for either singing or instrumental music. Of course, the teacher's role is paramount but more as a catalyst than as a director. A sensitive and enthusiastic choir leader can give a group the sense of sharing in the creation of the performance. Students can make good instruments and invent accompaniments by using auto harps, recorders, drums and so on. A very important function of musical leadership is to help performers see themselves as creators of the larger whole of which they are a part.

Evaluation in both art and music workshops should be in terms of the individual, his growth, his attitudes, work habits. To grade an individual art product suggests that there is an absolute standard. It makes the picture an abstraction — a number, a letter grade, that does nothing for the growing child and only serves to perpetuate one of the evils in the educational system.

Much more study is needed in the area of concept development, but it can be said with confidence that art experiences correlate with many disciplines of the curriculum and act as an integrating activity which involves the ideas and emotions of the students. They not only know what they are depicting, but doing it in their own way, using their personal symbols, they are saying "Yes" both to themselves and to life – a very healthy condition!

If study units are to be open-ended, then the teacher who is managing the learning situation needs to know as much as possible about the kinds of thinking which are characteristic of students at the age or maturity level with which he is dealing. Each child is ideally to go as far in the unit as his ability, the learning situation and, perhaps, time will permit. How can we as teachers know the children have developed an understanding? One way is to have them develop their own vocabulary for indicating what are for them new concepts. This is ductive form of verbalization. Do some children c tualize more readily in other ways, *e.g.*, in two- or dimensional diagrams, in model constructions?

Art materials lend themselves well to this t objectified integration of ideas and relationships. thermore, since language – whether understood or tends to have a sequential structure, it is limited used to represent a complex simultaneous or m feedback relationship.

MATERIALS

FINAL GROUP REPORT

THE objective of this group was to develop materials to act as vehicles by which the student would obtain a broad, fundamental understanding of a part of the world in which he lives as well as a personal sense of his ability to control and manipulate this "world." To accomplish this end, it is necessary to instill a sense of realism, personal participation, and personal accomplishment. We propose that the best way to do so is to let the student learn by personal experience. Links between all the disciplines will develop logically as a result of these first-hand experiences.

This method of learning is based on discovery and invention. The students are caused to discover their own lack of understanding, a necessity for understanding and then, through experiment and discussion, to discover the answers. The availability and use of materials are essential to the success of this experiential approach. The materials should be designed and presented to provoke investigation by the student and to cause him to ask questions. The student should be able to recognize a problem intuitively and become actively involved in its solution, rather than passively "listening" in a verbal jungle. In the development of any curriculum to provide this active learning experience, materials must be considered.

Learning Materials and Evaluation Criteria

The procedure for evaluating a system of education, or one of its components, is fixed by the criteria against which the evaluation is made. All systems consist of components, which in turn must be evaluated. One of the major components of an education system is its learning materials. But, since models of systems for the kind of interdisciplinary general vocational education plan being recommended by the Summer Study are not now in existence, a new way of evaluating learning materials must be created. The establishment of criteria for the selection and use of materials and their acceptance by the relevant public are vital and must precede the establishment of procedures for choosing or developing materials.

Traditionally, educational materials have been in the form of books, films, and classroom supplies such as paper goods, writing materials, laboratory equipment, and shop stores. While these goods may well remain the basic media, their uses will undoubtedly expand and change and new media will inevitably be introduced with curriculum revision.

The basic demand to be placed upon learning materials is that they aid effectively in making the abstract tangible. Materials must help to explain observed events. An event is explained when it is related to other events which are known; then it is shown to be part of an intelligible pattern of events. Many events can only be explained by linking them through material media to the learner. Materials, then, must show how an event needing no explanation (something the learner has learned) is connected with other observed events. Materials must connect the subject-matter with experience in ways the learner can understand.

Learning materials and project media must provide for diagnosis, analysis, and prognosis by the learners. The materials made to serve these functions cease to be inert pieces of laboratory or classroom hardware. The importance of the material is its function in helping the learner realize that X, having been stretched, explains some event of Y.

Learning materials must provide knowledge of matter in terms of properties, and they must also serve as media to enhance understanding of human relations in work. Knowledge does include skills as well as cognition. Materials have to lend themselves to directing interest (teacher and learner) toward group processes. Materials are the vehicles for the induction of changes in learners, changes that are behavioral as well as cognitive.

Another criterion for evaluating the usability of materials is the degree to which they are adaptable for children to teach other children. The teacher's task is always to bring together, via the processes going on in the classroom group, the externally dictated subject and the unique needs of each learner. Customarily, materials are chosen to bolster the centrality of the teacher where he assumes the role of transmitter of the heritage. The classroom exists to cause change in its learner members. Such changes occur as functions of the learning set and the kinds of materials present. Materials must link the learners, in many ways, to the theme of the story-line of the curriculum.

When setting out to select or develop learning materials, it is very important to realize that sorting out differences about subject matter may require more than merely gesturing at observable "facts." It may require a comprehensive reappraisal of one's subject matter.

Regardless of the difficulty of this task, it should not obscure the fact that nothing less may do.

Knowledge is not only a montage of sticks, stones, color patches and sounds, but the development of a system of propositions. How to do things with materials is not our sole basis for material selection. What the learner "sees" is also important.

When language and notation are ignored in studies of observation, subject matter is left resting upon sensation and low-grade experiment. This brings about repetition, monotony, and the concatenation of spectacular sensations and laboratory experiments. But school should not be just a systematic exposure of the senses to the world; it should also provide the learner with a way of thinking about the world, a way of forming conceptions. The educated person is not the one who sees and reports what all "normal" people see and report, but the one who sees in familiar objects what no one else has seen before.

Expressing the concept X in a language not yet rich enough to express X is always very difficult. Yet this is at least a practical limitation of the severest kind; and "practical" does not mean conceptually unimportant. As a criterion for the selection or development of learning materials this consideration is of importance because it illustrates just how intimately connected are concepts and the formal expression of them.

Thinking new thoughts in a conceptual framework not designed to express them requires unprecedented insights. When explanation, causation, and theorizing have become the learner's daily fare, each element of his speech will be worked into a comprehensive language pattern. Materials must serve the purpose of buttressing and supporting the expansion of the thinking-language pattern. Most of the learner's questions about the nature of causation are to a surprising degree questions about how certain descriptive expressions, in definite contexts, coupled together, complement and interlock with a pattern of other expressions.

The background information, the "set" that makes an explanation stand out, derives as much from discursive knowledge gained through materials as from what is obvious in situations. We are not born able to recognize such contexts, any more than we are able to "see" solutions to problems. Education is needed for both. Material media are the stuff of inference which, in turn, is intrinsic to education.

It takes material in a particular context to make a certain action into an experiment. If reading a sentence can strike one learner as viewing a painting strikes another, or making a clay tower strikes another, then manual skill should be accepted on equal terms with cognition.

It takes long training to master the techniques of design. To bring together a cluster of theoretical considerations in a single, tersely expressed hypothesis; to torture it in an experiment; to insure that discovered results initiate another phase of experimentation, and then to arrange that these in turn may become further phases of demonstrations is an experience seldom allowed learners in the classroom. Experiments are most often designed by someone else to be as chain-like as possible. Material selection for such experiments simulates the purchasing of ingredients for cooking recipes. Their effects are always contrived to rivet the learner's attention on some select sequence, ignoring a whole complex of possible sequences which may be more pertinent to the learner's purposes. In general practice in the schools, what is referred to as "causes" are theory-loaded from beginning to end. They are not simple, tangible links in the chain of sense experiences, but rather details in an intricate pattern of concepts. The feature of causation and explanation gets lost when concepts are forged in words alone and overlook the use of materials.

How investigation of any specific learning material is to explain phenomena growing out of them is not the issue of this conference; rather, we have attempted to explore the geography of some dimly-lit passages to better learning through the intelligent selection and use of materials. Intelligibility is the goal of subject matter, and it is the function of learning materials to help the learners attain this goal.

Materials

We know that learners form for themselves images or symbols of their externally imposed subject matter; the manner in which they form images and symbols and their consequences upon the individual are the basic concern of the teacher. Materials designed for learning have to help the learner arrange his images and symbols into logical patterns by integrating them with the subject matter dealt with in the classroom. Materials must allow the learner to convert what he knows into objects or, conversely, through working with materials to form images and symbolic patterns of thought. One knows the effectiveness of the materials of learning when the learner can do something in an ordered way which he could not do prior to a given experience. Too often, however, materials as used provide only "exposure" of the learner to information, procedures, or situations in bits and pieces. This is not altogether the fault of the materials. Sometimes the school schedule and the unrelated daily classroom activities are also at fault. The real tragedy, however, lies in the loss to the learner of the educational value of the materials and the subject matter. For example, "exposure" to visual materials could be better supported physiologically as an exercise of one's eyes than psychologically as a learning experience. Materials, in and of themselves, are not guarantees of learning. The wisdom with which they are developed, teacher understanding of their use, and the flexibility of scheduling for their use are factors which are prime determinants for optimum results.

Each kind of learning material — audio-visual, aural, lab equipment, or just "stuff" — has specific qualities by nature of the sensory stimulation it is designed to have upon the individual. If we are really going to provide all students with meaningful learning experiences and a chance of success, then ways are going to have to be found, and put into practice, to determine the effectiveness of learning materials upon individuals. What is basically needed in this area is showing the learner just how to use various media. For example, films frequently miss their intended mark with individuals because they do not know how to "see" the object of the film. The advocates of the discovery method will find cause to quarrel with this kind of deductive approach. Nevertheless, we as teachers or purveyors of materials err when we expect enlightenment from materials simply because they contain subject matter prepared by experts.

What is sought through the use of materials is the development within the learner of a process of application of thoughts to facts. This application is not necessarily limited to facts about the material, but about subject matter and interpersonal relations, and a host of other things. In determining how well the learner has assimilated the lessons, the traditional and universal concern with words needs to be de-emphasized in our testing procedures. In the present system, if a learner's words do not reveal his conceptions, he is judged by his words alone. The true appraisal of learning is to be found by observing what the individual does with it, not solely what he says about it. Criteria for the evaluation of learner progress have to be prepared in ways that will measure changes in operational behavior, and these criteria must square with the nature of the subject matter, the experiential base used for instruction, and the learner's pattern of response. Every criterion and device for evaluation must further provide reliable feedback that will indicate the degree of uncertainty that remains in the learner's mind so ways can be brought to bear to render uncertainty null without frustrating the individual. This is not "sheltering the child from failure." It is, at last, treating the learning process like a two-way artery of traffic, as so-called "logical" presentations of subject matter seem to require.

What we also have to do is to accept the truths of the teaching game and note false accounts of the problems as false. The whole nature of the evaluation act consists of knowing in what state the learners were when this or that change took place, and that just that change had to take place when it did.

The job laid out for the pupil is to accumulate experiences, fit and string them together somehow, and in the process become more aware of the possibilities of the world around him. The teacher, on the other hand, must endeavor to prepare the learning experiences in such ways that they each contain materials that are sensitive to all the laws of learning and will dampen the influence of single-factor evaluation.

Learning is a dynamic phenomenon, and it is always relative to some system of reference. The basis of pupil evaluation has to be broadened to include experimental verifications as well as verbal. Lord Kelvin once stated, "I never satisfy myself until I can make a mechanical model of a thing. If I can make a model, I can understand it. As long as I cannot make a mechanical model all the way through, I cannot understand it." This feature of learning by doing is a very common feature of vocational education, art, and industrial arts. It is required in science, the humanities, and communication. The pupil must make himself familiar with a considerable body of most intricate subject matter as he progresses through school. The first introductions, therefore, must be in simplified forms which the young mind can grasp. This is by no means a new idea. What is new is the formulation of patterns of articulation among the disciplines within the school so that they will mutually support each other. The results of articulation will bring together materials and subject matter as well as people. Only the limited imaginations of people will set boundaries to possibility. The main objective of materials is not to provide models, but to provide an interpretation of nature, mathematics, and humanistic values in terms that learners can understand.

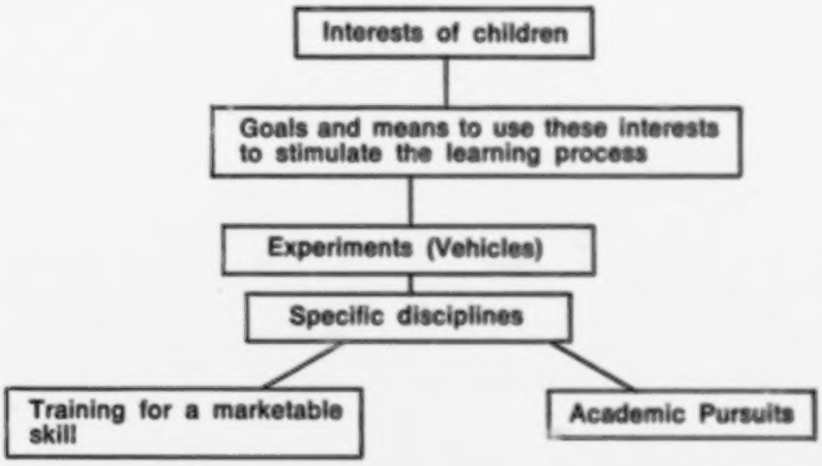
How should we regard a learner's report that he sees X if we know him to be ignorant of all X-ish things? Precisely as we would regard a four-year-old's report that he sees a meson shower. That the learner sees X suggests that he could specify some qualities pertinent to X. Evaluation is a process of finding out what the learner knows of X and determining the degree of uncertainty that remains about what he needs to know. At the least, the concept of seeing embraces the concepts of visual sensation and knowledge.

Another important thing that needs to be emphasized and re-emphasized is the way materials can help bring about a new way of looking at the role of structure in subject matter. Bruner states this relationship most clearly. "The teaching and learning of structure rather than the mastery of facts and techniques is the center of the classic problem of transfer." Everything is included in this view of teaching—exciting ways to gain knowledge, experience in applying knowledge, how to attack problems outside the school or later in life, as well as habits and skills that can be gained through working with materials. We need materials not for their extrinsic characteristics (boy-proof, safe, cheap, etc.) but for the intrinsic values gained in their combinations and design.

Materials Science Group Report

THIS report is submitted as a summary of the ideas which were generated in the Materials Science Group during the six weeks of the Summer Study.

The group concentrated on a program which would be suitable for implementation in the seventh, eighth and ninth grades for several reasons: 1) There are now some good programs being established at the lower grades. 2) The children at this level have had sufficient schooling to have a foundation in arithmetic, grammar, reading and history. 3) They have developed physically to a point where they have sufficient coordination to undertake some of these proposed experimental approaches. 4) A program with this age group is economically sound because it could produce some immediate effects in preventing dropouts and producing students with marketable skills and manual dexterity in the very near future. The program could then be extended downward and upward in grade level as needs dictate.


Interests of children
Goals and means to use these interests to stimulate the learning process
Experiments (Vehicles)
Specific disciplines
Training for a marketable skill
Academic Pursuits

The first approach to the design of a materials-oriented course for children of this age group was to consider the present education they receive and how it could be improved by the injection of such a course into the pattern. With this approach, we formed a block diagram as in left column.
The goals of this type of experimental approach to education were conceived to be:

1. To motivate a large portion of the student population to continue schooling and to create a desire for vocational training in many of the students.

2. To provide sound, if not complete, exposure and understanding of many basic interactions within our physical world.

3. To foster mutual respect between the currently classified "dull" and "bright" students.

4. To convert some of the verbally inept students to "bright" students by stimulation of interests of many of them who are in the "dull" category only because they are bored with the present education they are receiving.

The group then developed the means by which these goals could be reached by learning through investigation. In other words, these were the criteria to be used as guidelines for the development of examples of various experiments. The criteria are as follows:

1. Learning materials should be based on children's interests which have been developed by the students' environment.

2. The materials should be open-ended in order to provide for connection with future studies, to allow a student to continue inquiry past that for which the project was designed, to lead the student to a realization of the importance of the basic disciplines, and to accommodate the varying capabilities of students.

3. The materials are intended to broaden the interests and competence of the student, to stress non-verbal, sensory-oriented learning, to illustrate the necessity of qualitative measurement and to offer possibility of some success for each student. The avoidance of the present confusing terminology used in the sciences would probably increase the possibility of success.

4. The materials should also provide interaction among students by being designed for individual or small group use whenever possible. They should be as inexpensive as possible, reliable and functional.

During the first four weeks this group split up in various ways. First we tried to work individually on devising experiments which would meet most of the criteria listed above. Out of these individual efforts, only one experiment which would meet most of the requirements evolved. This experiment was about the internal combustion engine and is included later in this report.

Next we divided the group into sub-groups of about three individuals with one of these sub-groups further developing the internal combustion engine experiment, another subgroup developing a set of experiments with engineering materials as the core, and the third subgroup concentrating on electricity, and the fourth subgroup working up an idea on boats and stability.

At the end of the four weeks, the group had developed experiments centered around internal combustion engines, engineering materials, water systems, monetary studies, electricity, boats and consumer research testing. Outlines of these projects are included in another section of this report.

We discovered that we could continue to develop many experiments to meet these criteria. Each experiment could be developed in endless detail, but the members felt that this would be wasted effort, for no matter how many we developed, we could not meet the needs of all teachers in every area of the country. We came to the conclusion that we could only offer samples of ideas and that the teacher teams would have to project themselves into their own local environment to form experiments which would be germane to their particular community.

The implementation of such a program has been a nagging question in the materials group. We considered how we could present these examples to a team of teachers in such a way that they would become enthusiastic enough to involve themselves and the students deeply in the experiential learning process. We attempted to analyze what there was about this program that made the Educational Services Incorporated personnel so engrossed in their work and what it was they said or did to get the members of this group so excited about the program. We began this approach by listing everything we could think of that would convince a group of teachers that this was the best way to get a student to learn at rates and in depths beyond all present comprehension.

We thought that perhaps a "Madison Avenue" approach such as the design group had created would initially get many teachers interested enough to form a teacher team and develop a program of their own. Once the program is underway, they may become "hooked" by the student reaction and the results. We considered the use of pictures of students in a presently typical classroom atmosphere contrasted with a group of enthusiastic students clustered around a project work table with a variety of provocative questions. Perhaps the "crisis" stimulus could be used as effectively as it has been used on the public in the past?

After attempting to package these sample experiments three times with a written precept which would stimulate a team of teachers enough to improvise their own projects and carry them through to a conclusion which would provide continuing stimulation by the results, we came to the conclusion that this initial stimulus could only be given by retraining centers and by demonstrations of results in other areas.

Another problem of implementation we considered was how to insert such an experiential program into the present school curriculum. This program might replace a present science course in seventh grade and have teams of teachers (*viz.*, math, English, social studies, etc.) supporting the project in their classes. Great care would have to be taken by all teachers in this sort of a team to prevent artificiality in the supporting classes.

As the experiments gradually began to expand from an engineering materials viewpoint into more broadly-based ideas such as the investigation of water systems, consumer research testing, electrical systems and monetary studies, we began to realize that successful implementation posed many more questions. Such questions arose as:

1. Should the entire curriculum be based on one project with many supporting disciplines?

2. Would it be better to have several projects with mutual support between disciplines?

3. Would it be best to have a project for each subject to be studied by the student?

4. How should these experiments be presented to get a team of teachers enthusiastic enough to perform the extra work required for this type of teaching?

At various times, the materials core program and the water systems project were tried out on various types of students to test the ability of these ideas to capture the interests of students in a heterogeneous population. All exposures of the students to the experiments indicated immediate and intense interest, but this group felt that retention of student interest for a long period of time would be extremely difficult unless the teacher teams became very involved with the students in their learning processes. From these experiences, it is evident that placing these experiments in the hands of teachers, as presently developed, would be very dangerous to the success of the movement. There would be a great possibility of failure and, hence, a great disenchantment among the teachers for this type of learning.

With the above realization, further discussions on the implementation revealed the need for a national government-sponsored, non-profit institution, hereafter called a "half-way house," to develop learning material ideas in further detail for future transmission to teaching teams.

We envision a half-way house which would consist of the following types of personnel on an as-required basis: A technical director or coordinator; outstanding elementary and secondary school teachers; technicians; university personnel; industrial personnel; and union representatives.

The functions of a half-way house would be:

1. To develop additional learning materials which meet the criteria listed in this report plus criteria set forth in the future.

2. To act as a coordination center for the use of materials suggested by feed-back from teachers plus innovations from different areas of the country.

3. To maintain a nucleus staff for continuity and a continuously changing flow of consultants from the various sources listed above.

4. To develop pilot programs to test new materials, ideas, and methods before dissemination to the teacher training centers and teams.

5. To obtain financial support for implementation of the programs.

6. To give direction and structure to the development of learning materials.

7. To determine the specificity or the generality of experiment outlines distributed by the centers.

Obviously, this group concurs with other groups of this summer study about the necessity for the establishment of regional teacher retraining centers, the introduction of new concepts of teacher training in the colleges, and the institution of pilot programs.

Conclusions

1. It must be demonstrated to teachers that this experiential learning works.

2. There must be a teacher incentive system instituted in school systems which will really work toward getting the teachers interested in the improvement of teaching methods.

3. Teaching must be accomplished by an interdisciplinary team of teachers.

4. The team must accomplish the final development of their projects.

Recommendations

1. Some access for teachers to be exposed to this retraining program must be provided.

2. A "half-way house" for development, coordination and implementation of new programs must be established.

3. Effective incentive systems for teachers to be retrained to provide experiential learning techniques for all students must be created.

4. Team teaching must be developed to present this type of learning effectively.

5. Teams should consist of a teacher from each subject, an administrator, and any outside help from the community which may be deemed advantageous.

Materials Science Group

ONE of the ingredients of the success of an experimental approach is the availability and use of materials. The materials should be designed and presented in a manner to provoke the student to question. He should be able to recognize intuitively and answer a problem by doing, not verbalizing it. The teacher should recognize this answer as valid, and the depth of study should be determined by the student's capability to understand. In the development of any curriculum, materials should be considered, and the design should be open-ended. The use of these materials should stimulate in the student a desire to continue to an objective. In the process of reaching this objective, the student will recognize need for certain concepts and can investigate their nature.

The teacher, indirectly, should encourage the student to investigate methodically and try to relate the work to his material interests and environment. The teacher should be prepared to say, "I don't know, but let's find out." The student then brings the teacher into his problem.

However, if each and every teacher became his own designer, and the shops became a production process, this approach would be cumbersome. Some direction should be given from a central committee or group (*i.e.*, Educational Services Incorporated). With variations and models being formalized within the school to meet individual requirements, further research and development should be carried out within a teacher training center and cleared through a central committee. This developmental work would include the creation of basic, inexpensive materials that the students can duplicate if desired, but not specific class projects.

Materials should be constructed with the age group's manual dexterity in mind so that neither confusion nor frustration will develop and so that transactions with the material are definite but provocative of new questions to be answered. There should be no assumptions or hidden knowledge that the student must use, yet never sees, to obtain his results, and results must be unambiguous and intrinsic, not culture-bound. Some research should be required, but the materials should stand on their own to verify this research.

If the student sees an effect and misses the cause, the materials by his manipulation should answer the question, "Why?"

It is recommended that materials for junior high school should be designed immediately and implemented where possible with existing curricula to encourage a laboratory-oriented situation. The phase to team teaching will take time, but equipment placed in the hands of students to encourage their participation could occur in a short period of time.

Proposal for a Laboratory Oriented "Vocational" Course in Materials Science at the Seventh Grade Level

A Memorandum to Chairman of the Materials Science Committee

July 19, 1965

THE ideas expressed herein are not meant necessarily to reflect the viewpoint of the committee as a whole. On the other hand, they are not all, by any means, original with me. Instead, this report is meant to express what I consider to be some of the more fruitful ideas from our committee as a whole, and particularly from the subcommittee of which I was a member.

I have listened with growing interest during the last two weeks to the need to broaden our proposed course beyond simply engineering materials, and perhaps beyond materials, or even beyond "things." (An example of the last category is the suggestion that laboratory study in animal behavior might appropriately be part of such a course.) I have been impressed with the fact that the degree of motivation we can anticipate in our students is probably much less than I had hoped for. It has been made evident to me that a major, and perhaps the only, immediate goal of the proposed course is to provide a stimulating laboratory experience for these youngsters.

Our subcommittee has chosen to concentrate on the relatively narrow field of Materials Science. Through concentration in this field, logical links can be developed from the materials to the world in which the student lives, including such formal disciplines as mathematics, history, and economics.

It is proposed that a laboratory-oriented vocational course in Materials Science be formulated as a two-term sequence at the seventh grade level.

The primary academic goal is to provide a unified course from which the student will obtain a broad, fundamental understanding of a part of the world in which he lives, as well as a personal sense of his ability to control and manipulate this "world." Links are expected to develop logically outwards to discipline such as mathematics, history, etc.

A very necessary and immediate aim of the course is to instill a sense of realism, excitement, personal participation, and personal accomplishment. Hence, for many, and presumably most, this requires a laboratory-oriented, "vocational" course. The teaching of "saleable skills" is a matter for later years, and certainly courses for this purpose are expected to build logically on the proposed course.

For many reasons, discussed at length elsewhere, we have made the initial assumption that some "vocational" education is desirable for all students at about the seventh grade level, as well as, presumably, above and below this level. The goal of these "vocational" courses is to provide broader fundamental understanding than is now generally being taught.

The exact field of study (*i.e.*, "Materials Science," "Design," etc.) is clearly less important than broader academic and social goals. However, a precept of this study is that some well defined field should be studied in depth, and that only in this way can the primary academic goal be met. "Materials Science" offers the following potential advantages: It brings realistic experiences to all students; it can be presented as a laboratory oriented course; it is a suitable vehicle for meeting the primary academic goal.

A requisite for the proposed course structure is a course based on natural interests in materials, systems or processes. The course must employ open-ended experimentation instead of the standard "canned" experiments and should develop competence and interest in basic concepts and materials. Another vital purpose of the course is to help students discover a "need" for mathematics, quantitative measurement, etc. This need is to be discovered through real experience. Finally, the course structure and philosophy should ensure continual updating.

We recommended that the course be built around a series of laboratory experiments, such as that in Table I below. The laboratory work would be divided into three phases. Initially, creative shape manipulation would be emphasized. Later on, laboratory experiments would focus on the properties of materials, and finally, manipulation of those properties. The underlying thread of the course is to be materials; specifically, basic, lasting concepts of materials. Such lecture material and outside reading as are to be assigned would deal with these concepts logically and in conjunction with the course structure and introduce principles only as a natural part of the laboratory-oriented course.

Table I: Outline of Simple Laboratory Experiments for Vocational Course in Materials Processing*

A. **Creativity with Materials—Shape Manipulation**

Metal Casting
Electroforming
Pottery-making—powder metallurgy
Crystal Growing
Metal Forging—plastic forming
Glass Blowing

B. **Measurement of Properties of Materials**

1. Physical Properties
   Thermal conductivity
   Electrical conductivity
   Thermal expansion
   Density
   Magnetic properties
   Hardness
   Melting point
   Color, transparency, opaqueness
   Corrosion
2. Mechanical Properties
   Tensile properties (including those associated with elevated temperature)

C. **Manipulation of Properties**

Alloying
Cold-working
Cross-linking of Polymers
Heat Treatment
Composite Fabrication
Corrosion Control

* Topics listed are for example only.

SAMPLE EXPERIMENTS:

A. Experiment in "Creativity with Materials—Shape Manipulation"

Problem: As homework, take home a piece of foam plastic (styrofoam) and carve, or otherwise shape, whatever you wish (a piece of sculpture, an ash tray, a cooking utensil). Bring it in to class next week and cast it, using the sand molding process.

Suggestions: For shaping the styrofoam, a pocket knife, file, sandpaper, etc., are ideal tools. Also, if you paint parts black and leave others white, and then expose the styrofoam to a bright light or heat lamp, you will find a depression in your model forms wherever you painted black.

For casting, aluminum is ideal, and prepared sand is available. Necessary materials and furnaces are available. Some sketches in the laboratory show suitable methods of forming the molds. You may wish to plan your own molding procedure after consulting these sketches.

Suitable recipes for melting aluminum are placed near the small bench furnace. Be sure to wear gloves, face mask, and asbestos apron when melting and ask your instructor for assistance in pouring.

NOTE: No attempt is made in this or other experiments to use language suitable for student use. The aim is only to describe, for purposes of this conference, the type of laboratory envisioned.

In addition, no attempt is made here to include material suitable for presentation as lecture material, homework, or outside reading. It is assumed that this "academic" material is to be developed to follow and logically to support the experiments performed and, most important, to provide the continuous thread to the course. This thread is to be a fundamental understanding of materials and methods of manipulation of these materials. Through this thread, ties are to develop outwards to mathematics, physics, history, economics, etc.

B. Experiment in "Measurement of Properties of Materials"

Problem: Cooking ware is generally, although not always, made from metals. This is because certain properties of metals make them particularly useful for this application. These properties of metals include ductility, high temperature strength, cheapness in initial cost of materials and in fabrication, and ability to transmit heat. Consider the materials to which you have been exposed from the standpoint first of only their ability to transmit heat. What material do you recommend for use in making a frying pan?

Experimental Approach – Some Limits: There are many ways in which you might compare, and assign numbers to, the ability of different materials to transmit heat. Figure 1 below shows one example. Using this technique, you can assign relative numbers to this quantity for different materials. How?

Following, in Figure 2, is another example. Again, you can assign relative numbers to the different abilities of materials to transmit heat. How?

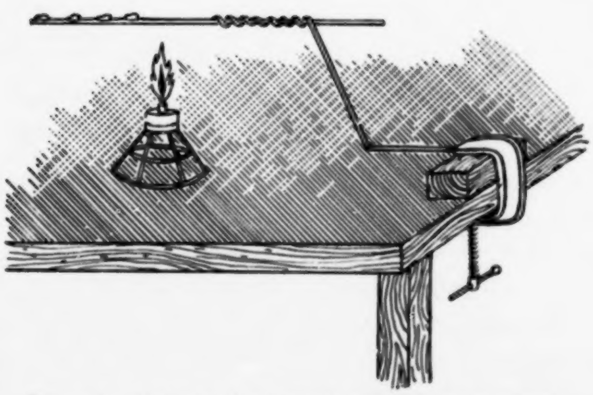


Figure 1: Apparatus for thermal conductivity experiment.

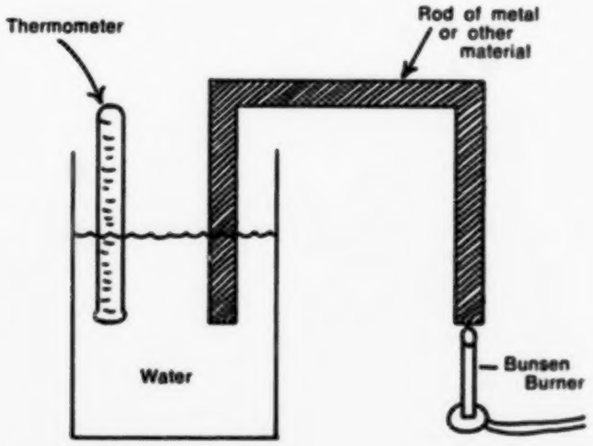


FIGURE 2

Introduction of Science Materials in Junior High Schools

WHEN one thinks or talks about the wonders of modern science, it staggers the imagination to realize its impact on society throughout the world. Men of vision have made this achievement possible. To continue our success in the sciences we need more "men of vision." We can start to develop our future "men of vision" right in our Junior High Schools. The exact field of Materials Science is clearly less important than broader academic and social goals. However, a precept of this study is that some well defined field should be studied in depth, and that only in this way can the primary academic goal be met. Materials Science offers the following potential advantages: It provides a realistic experience for all students; it can be presented as a laboratory course; it is a suitable vehicle for meeting a primary academic goal.

Many materials can be studied. However, an excellent course can be built around a series of laboratory experiments with the properties and applications of three materials – plastics, ceramics, and metals. Laboratory work would be divided into three phases. Initially, creative shape manipulation would be emphasized. Following this phase, laboratory experiments would focus on the properties of these materials, and, finally, the experiments would deal with the manipulation of the properties of these materials.

An outline of simple laboratory experiments on Materials could be:

A. **Creativity With Materials—Shape Manipulation**
   - Metal Casting
   - Plastic Forming
   - Ceramics—Shaping and Bonding
   - Crystal Grouping
   - Metal Forging
   - Powder Metallurgy

B. **Measurement of Properties of Materials**
   1. Physical Properties
      - Thermal Conductivity
      - Electrical Conductivity
      - Thermal Expansion
      - Density
      - Magnetic Properties
      - Hardness
      - Melting Points
      - Color, Transparency, Opaqueness
      - Corrosion
   2. Mechanical Properties

C. **Manipulation of Properties**
   - Alloying
   - Brazing-Soldering
   - Heat Treatment
   - Corrosion Control
   - Composite Fabrication
   - Cross-Linkage of Polymers

Under the guidance of a trained team of teachers this phase of the curriculum could be competitive and exciting as well as progressive. Students in the classroom could be grouped into three teams: One group would represent the plastics industry; another group would represent the ceramics industry; and the third group would represent the metals industry. Teachers could create a highly competitive industrial situation within the confines of a classroom. A problem could be created in which a corporation has asked for quotations on a product that could be made from any of the three materials. It would be up to each group to decide how it could produce the item and sell it at a profit. They would use their own ideas about design, equipment, quality of material, production schedules, inspection and quality control procedures. Before each group could arrive at cost estimates and selling price, the students may have to do a great deal of research and data accumulation. The essential information for making the estimates would include the following:

1) Material resources and their availability.
2) Technical information from industrial engineers.
3) Technical data and material costs from suppliers.
4) Type of production equipment available.
5) Procedures essential to guarantee profit.
6) Financial information from accountants.
7) General information from conferences with teachers.

Such an educational program could be the very spark necessary to fire the imagination of a student. The pleasure and satisfaction derived from this kind of activity could also convince him of the necessity of a good education.

Such a teaching concept accomplishes many things within each student. He is made to feel that he is part of a team; that he is needed and must therefore assume responsibility. Success or failure can only be measured by the ability or inability of a member of a team to make his part relevant and effective. He will learn that ability in oral and written expression may be decisive in presenting and defending his ideas to his team members.

The need for good knowledge in mathematics, chemistry and physics will become apparent. The origin and development of the materials provide a natural basis for studying history and social studies. By experience, the student will learn the value of the ability to work in harmony with members of the team. Most important, working with a group that can develop a product successfully, can decide what its requirements should be and, if necessary, can manage to get a successful product, will offer each student a gratifying learning experience.

What centers of interest could a materials course generate? Historically one can learn that without the knowledge and proper use of these materials, science as we know it would be nonexistent. Our way of life is dependent on materials. Thus, the importance of students learning in junior high schools the fundamentals of these materials is evident. This knowledge should be expanded. This knowledge can really be increased in depth in technical institutes and engineering colleges.

To begin learning about materials in junior high schools, students could start with the following activities:

1) Visually determining the basic differences between a plastic, a ceramic, and a metal.
2) Experimenting – Separation of Materials.
3) Identifying – Metal – Non-Metals.
4) Manipulating Materials.
5) Compiling of Data.

The following are examples of student research and the skills that could be developed:

1) Separation of metals and non-metals by color.
2) Identification of metals.
3) Use of a magnet to separate magnetic and non-magnetic materials.
4) Use of a file to test hardness of materials.
5) Recording of data on identified materials.

By these experiences the student will learn first-hand that the identification of materials by color can be misleading; that some metals are magnetic and others are not, and that file tests indicate some metals are harder than others; and that the discovery that metal is magnetic may not clearly identify it. He will have achieved a basic understanding of these facts by discovering them himself.

Further research and skill development could demonstrate that chemical analysis (especially of the metal) is entirely different from other property analysis. From his own experimentation the student could discover that some materials resist oxidation better than others; that metals in general have good thermal conductivity, while plastics and ceramics are poor conductors; that metals in general have good electrical conductivity, especially copper and alumnium, while plastics and ceramic are good insulators against electricity; and that the tensile properties of metals are higher than either plastic or ceramic.

Since ceramics are both heat and oxidation resistant, the expansion and contraction properties of a ceramic are much different from those of a metal. Once the student has learned these differences, he could appreciate the significance of the successful bonding of a non-metal to a metal and the range of application of this technique.

The above are only a few of the properties of materials, but they indicate that each has its place in the field of engineering. From direct experimentation the student will learn the potentialities of these materials, and that, if properly applied, a material will do the job for which it was intended.

Sample Experiment in Conductivity of Metal

Topic: Thermal Conductivity in common metal.

Experiment Objective: To demonstrate that metals vary in their ability to conduct heat.

How can we demonstrate it?

What do we mean by thermal conductivity?

Equipment and Material:

alcohol lamp
wax candle
clamp and fixture for wire holder
6 inch scale
small file
watch
copper, aluminum, berryllium copper, brass, steel, and stainless steel rods of the same length and diameter

Procedure and Data Accumulation – Set up apparatus as shown in Figure 1. (See "Memorandum"). Measure off a point 5 inches from the end of a rod. Mark this point by scratching with the file. Scrape some wax from the candle onto the tip of the rod and three other points between the tip and the 5 inch mark. Insert the other end into the wire holder. Light the alcohol lamp. Place it so that the flame is under the rod at the 5 inch mark. Note the starting time.

How does the metal react to heat?

What happens to the wax?

How long did it take to melt the wax at the end of the rod? Do you think it would be wise to record your data in a notebook?

How would you do this?

Follow the same test procedure with all of your rods.

How long did it take for the wax to melt at the end of each rod?

From your rating system which metal would you say was the best conductor of heat? Why?

Which metal was second in your rating?

Which metal was the poorest?

What conclusions have you drawn from this experiment?

Is there a table on thermal conductivity in your reference book? How would you use it?

How do your results compare with the actual values?

Home Assignments

How would you rate your mother's cooking utensils on their ability to conduct heat?

Did some utensils have special handles? What function do they have?

Did you find some pans made of two metals?

Why is the copper used?

Do you think copper would make a good frying pan?

Outline for your mother a list of cooking utensils most efficient for cooking.

Experiments in Creativity with Materials

Casting

1. Have student carve or file out an object of his own choosing from a styrofoam block.
2. Pack the styrofoam form the student created into molding sand with suitable binder.
3. Pour molten aluminum or brass into the "gate." The metal will melt the styrofoam and will fill this cavity and produce a form which will have the same surface texture on the metal as the styrofoam.
4. Repeat this process using "pot" metal and note some of the differences in the molten condition of the two metals.
    - Melting points
    - Fluidity – ability to be cast in thin sections
    - Shrinkage on solidification
5. Drop the two identical forms on the floor to see whether they break.
6. Design experiment so there will be success – forms that are
    - Pleasing to the eye
    - Strong

    and failure – forms that have
    - Shrinkage cavities
    - Cracks
7. Provide bibliography.
8. Provide supplementary casting experiments (*i.e.*, a ring or brooch mounting) for those who are interested.
9. Allow options to cast structural shapes – – for later measurement exercises by the class.
10. Work in *some* ideas of melting points and temperature-measuring devices during free times – thermometers, thermocouples, optical pyrometers.

Plastics

1. Use Lucite. Heat in boiling water and bend into creative shapes.
2. Use some cold setting plastics and expoxies, pouring them into molds which were created by the students. As the epoxies harden, note the heat given off.
3. Mount items in cold setting plastics.

Electroforming: Depositing metal on a non-metallic form.

1. Deposition of metal using natural things as the form.
    - Shells, small crabs, etc.
2. Plating on such items as pine cones for Christmas ornaments.

Ceramics

1. Typical ceramic items – dishes, figures, etc.
2. Glasses.

Crystal Growing

1. Growing crystals from salt solutions.

Powder Metallurgy

1. Slurry of metals.
2. Pressure compacting.
3. Composite materials.

Sample Program in Mechanical Sciences

IN the course to be developed below, I have taken the gasoline engine as a base from which to develop certain aspects of materials behavior, electricity, chemistry, and applied mechanics of physics. I have assumed that there is a substantial portion of students in the seventh, eighth, or ninth grades who are sufficiently interested in power and mobility to exhibit some natural interest in a gasoline engine. The engine merely forms the vehicle through which we can obtain initial interest, and from which we can draw significant conclusions and concepts.

As a starting point, consider a class of perhaps twenty or thirty students divided into *heterogeneous* groups of four. Thus the groups may contain both boys and girls as well as both "bright" and "dull" students. For lack of better words "bright" and "dull" students refer to those who currently are classified as the AB (bright) students and the C-F (dull) students. Each group is provided with a sturdy work table, perhaps 3′ x 6′ which will serve as both desk and workbench. Each group also has a ½ H.P. four-cycle gasoline engine, mounted on a sturdy base, and in working condition. Each group has a sufficient kit of tools to disassemble and reassemble the engine. The tools may well be arranged on a fitted rack so that at the end of each session it is easy to check for missing tools. As the course develops, the groups will be provided with specific equipment for the investigation of various problems. The room should be fitted with a simple fuel and exhaust facility to permit operation of one engine at a time.

In an endeavor of this type, the first class meeting is most important. When the class arrives for the first meeting, the engines and tools are at the table, and the students are simply asked to take a seat.

The teacher tells the students that they are going to operate as basic groups of four, that it is very difficult to choose groups on a sensible basis, so they will do it "Las Vegas Style" – by using a roulette wheel. Each student is given a number from the alphabetical class list, the wheel is spun and the first student so chosen goes to table A, the second to table B, etc. until four students are at each table. The students are told to remember their numbers, because the wheel of fortune will turn often before the end of the year.

The students are told that the tools and engines will be their responsibility for as long as they work with them. They are also told that at the end of the year, two or three engines, and perhaps one set of tools, will be given away to passing students in the class. The particular engines which are given away, and the students who get them, will both be decided "Las Vegas Style."

The students are then given their first assignment: to disassemble the engine completely. They are to take it apart, deciding what function each part performs, and must remember how the engine came apart because eventually they will have to put it back together again. They are told that for this part of the course they will be graded on how well they reassemble the engine, and how well they figure out the purpose for each and every part.

The students are then turned loose to take the engine apart. During the taking apart, the teacher must use his time skillfully, because he would like all groups to finish at about the same time. For those who move along rapidly, he can slow them by asking questions regarding function; for the slower group, he can help them decide how to take it apart. He should make a general comment that it will probably be several weeks before they reassemble the engine, hence if an assembly looks difficult, they may want to make a sketch, keep a list, tag the parts, or take notes as they go along to help them remember. Before disassembly, he could ask the groups to guess the total number of parts.

The disassembly will be primarily group activity and may last two to four hours. Following this there will be several hours of class discussion when each part is discussed. This section is critical in that here we will "master-mind" the discussion to develop those questions which we may later want to follow up in some depth. During this discussion, the class should develop their own "parts list" on a blackboard or chart. Here they would give a name to the part and record the unanswered questions. To give some idea of what I envisage might take place, I have listed questions for a number of parts. In each case I have extracted certain questions which will not be properly answered, and which can be used for the studies in more depth.

Discussion

HEAD BOLT: What is it for? What can we call it? How many are there? Why is it this long? Why is it this diameter? Suppose it was smaller? Bigger? What is it made of? How do you tighten it? Too little? Too much?

Questions which can be answered in depth through further experimentation and calculation:

1. How strong is bolt material?

2. How can you properly tighten a bolt?

Piston: What does it do? What shall we call it? What are the grooves for? What is it made of? How critical is the diameter? Could it be longer? How much? Why doesn't it wear out? What does oil do? Will wa. . work? Why not?

Questions in depth:

1. How much longer could it be?
2. Why is oil a better lubricant than water?

Spark Plug: What does it do? What is ceramic part for? Why not rubber? Plastic? Is gap size important? How tight?

Questions in depth:

1. Why ceramic rather than plastic?
2. Does gap size affect performance?

Condenser: What does it do? (probably no one in class knows)

Questions in depth:

1. What is a condenser?
2. What does a condenser do in the engine?

Coil: What does it do? Where does the electricity come from? Why are there three (four) wires? Why copper wire?

Questions in depth:

1. How is electric current generated?
2. How does transformer work?
3. Can you use a battery to replace magnet system?
4. What voltages are developed at primary and secondary?
5. How can we work wires for conductivity?

Breaker points: What do they do? When is spark formed? (opening or closing?) What materials?

Questions in depth:

1. Is point gap critical?
2. Why do points wear out?

Carburetor: What does it do? How can throttle valve control speed? Where does the gasoline come in? Why does it come in? How much comes in? What does the float do?

Questions in depth:

1. What happens to pressure inside carburetor as throttle is moved?
2. Why is gasoline "sucked in"?
3. How much fuel does an engine use?
4. What happens with either too much or too little fuel?
5. Why is there a particular fuel-air ratio?
6. Does an engine power increase or decrease on hot days or on high mountains?
7. What is a horsepower?
8. How much energy is there in gasoline?
9. What is efficiency?
10. How efficient is your engine?
11. How long should your engine run on a gallon of gas?

Valve spring: What does it do? What is it made of? Why is it that size? What would happen if the wire were thicker or thinner? What if spring were longer or shorter?

Questions in depth:

1. How do you describe quantitatively the stiffness of a spring?
2. How does spring stiffness vary with wire size, spring diameter, and spring length?

It becomes clear that the number of questions that can be asked about an engine and its parts is limitless. In the course, the teacher must know when to stop general discussion and start the groups working on the answers to some of the questions. I would guess that two to three hours of discussion should bring out a number of questions to be answered in depth. At this point, we have the choice of having the entire class working (individually or in their groups) on the same question or having several groups working on different questions. It is advisable that all groups work on the same problem at the outset, then permit flexibility as time goes on.

For most of the problems, simple experimental equipment will have to be provided. The equipment should be sufficiently general so that the students have some choice about what they do, what they measure, how they express their results, etc. I shall attempt to illustrate what I have in mind by outlining equipment and methods which could be used to answer some of the questions in depth.

Format

One of the problems associated with using a complex device such as an engine as a teaching vehicle is the rather long time span that may exist between starting, in this case taking the engine apart, and seeing the reassembled engine run. Another problem is that there are a few critical points which must be attended to during assembly or the engine won't work, *i.e.*, tightening of connecting rod bolts, assembly of timing gears, positioning of coil, and setting of breaker points. In order to meet these problems, we feel that the general subject format should be as follows (and this format will apply to other energy conversion devices):

1. Disassembly of engine, each group to attempt to determine the function of each part.
2. Assembly of engine with simultaneous discussion and experimentation associated with various parts.
3. Operation of engine, and class tests on complete device.

In order to simplify step 2 above, we could note that, for successful operation of the reassembled engine, there are a number of bolts which must be properly torqued. Hence, the first discussion following disassembly should be "How Tight Should You Tighten A Bolt?" Following this experiment, the groups can be introduced to torque wrenches, and told how tight certain bolts should be. Again, when the time comes to assemble the timing gears, which must be properly positioned, we can introduce the discussion on "Why are the gears of different size?" This general process can be followed at each critical assembly point so that as time goes forward, the engines take shape in a "probably workable" fashion. Thus the manual assembly operations are interspersed with questions in depth.

In this "engine" example, we will discuss a number of "questions in depth." It is doubtful that any teacher or class will want to pursue them all. The number will be gauged from the class interest. When interest lags, we move on quickly, omitting some questions in depth so that we can attack another vehicle – record player, hair dryer, etc.

Questions in Depth

I. *How tight can you tighten a bolt?*

In order to answer this question, I want the student to be forced to resort to measurement, and to determine the concept of torque or moment all by himself. He should find out, not be told, that a unit such as an "inch-lb." is a quantitative measure of bolt tightness. He is told that he has to report to the teacher in words (not by feel) how tight a bolt is. We provide each group with a simple kit consisting of:

1. A steel bar, drilled and tapped for 1/8", and 1/4" bolts; four holes of each size.
2. Steel and aluminum bolts to fit with washers.
3. A variety of wrenches.
4. A spring scale (0-25 lb.) and a ruler.

The students are then "turned loose" and asked to report to the teacher when they can answer:

1. What is the measure of tightness?
2. How much tighter can you tighten a 1/4" bolt than an 1/8" bolt?
3. How much tighter can you tighten steel than aluminum bolts? For the quicker groups, the teacher gives them heat-treated allen cap screws and asks them to find their characteristics.

When the individual groups have obtained their answers, there should be a class discussion. First, the results of the various groups should be put on the blackboard in tabular form showing the variation. A short discussion of variation will lead to average values which can then be established and the variation with diameter and material discussed. We should also discuss here the fact that torque, or twist, or whatever they choose to call it, can be represented in terms of a unit such as an in.-lb. We should point out that there are only a few truly basic quantities. For mechanical systems, we may choose force, length, time, and temperature as our basic quantities, represented by lb., inch, second, and °F. All of our other quantities, some of which the student knows about and some of which he doesn't, are made up of a combination of these. Thus the twist of the bolt is in in.-lb., or the speed of a car might be in in./sec.

It should also be possible at this time to note (with proper bolt measurement) that in doubling the bolt diameter the breaking torque went up by a factor of 8. The relationship between 2 and 8 can be explored with $2^3 = 8$ being the applicable result as compared to $2 + 6 = 8$, $2 \times 4 = 8$, $10 - 2 = 8$, etc. It can be given as an optional problem to suggest why the cubic law holds.

II. *How strong is a metal?*

As a direct consequence of the previous experiment, we know that aluminum, mild steel, and H.T. steel do not require the same torque for twisting off bolts. Hence, the question "How strong is a metal?" is a natural follow-up. Again, we should not tell the students that the quantity which can be used to express strength is stress (lb./in.^{2}), but should lead the groups to discover that it is the only unit that makes any sense, and have them assign a name to it. We also want them to discover that metals have elastic regions and plastic regions. While a bend test is easiest to make, the quantitative interpretation of results will be easier with a simple tensile test. In order to employ low forces we can pull wires of .010" and .020" diameter. In order to measure elastic deformation, the test specimens should be as long as the work table (70"). The load can be applied using a pulley and weights or a spring scale. If we can obtain wire of copper, soft iron, and piano wire, the student groups should be able to develop for themselves the concepts of elasticity, plasticity, yield point, stress and strain. They probably can be led into the concept of elastic modulus.

Where various groups have obtained their numbers for characterizing the materials, there should be a group discussion where again the individual values are tabulated to indicate the spread in their data. The group should be asked why the data are not identical, and should be prodded into determining what factors probably caused the most variation. Each group could then be asked to design or invent a system which they think would do a better job. Finally, they should be told what the common nomenclature is, and what typical stress-strain curves look like. They can logically discuss the difference between "strength" and "toughness."

It would be highly desirable at this point to have them see if all solids act like metals. We can doubtless obtain glass fibers as well as monofilament nylon, perhaps a mylar recording tape, paper and rubber. We should be able to develop the concept of brittle versus ductile fracture. We can experiment with solder to see if we can have them discover creep. With the solder, nylon and piano wire they should see what happens when the material is heated a bit and then allowed to cool.

It is conceivable that for the brightest students, we can try to get them to develop a relationship between twisting and tension fracture.

III. *How stiff is a spring?*

The concept to be developed here is that a spring can be categorized by a "spring constant" expressed in units of lb./in. The experiment is simple, merely requiring springs where length only is varied, and others where spring diameter and wire diameter are varied. A force scale and a ruler are all that is needed to run the experiments. We want the students to determine for themselves that the units for describing a spring are lb./in.

IV. *Ignition system*

Where does the electricity come from?

This topic is more difficult than the previous ones because we cannot readily observe an electric current. We must resort to meters. We could start by saying that in an automobile, the electricity comes from the battery, but in turn we must "pump up" the battery with an alternator or generator. In the system at hand, we have eliminated the "middle man."

There have been a great number of experiments developed for showing the action of magnets on coils, transformers, etc. We should use these in conjunction with a mock-up of the ignition system and an oscilloscope to have the students determine the function of the parts.

V. *What is a "horse power"?*

The concepts that can be developed here are many and varied. Some of them will require a substantial degree of abstraction, but the basic topic is familiar. Here, we want the student to find that there is a quantity that we call energy or work, and that power is the rate of doing work. I am not sure what will be the best way to approach this subject but one way would be through a discussion of why we must put gasoline in the engine; what is the characteristic of gasoline which makes it useful; and why more powerful engines use up more gasoline per unit time. Hopefully, we could develop the theme that it is the heat of combustion, available from the gasoline that is the important quantity, and that the engine converts thermal energy to mechanical energy.

Another approach would be to consider the engine as a machine that "takes something in" (air, fuel) and puts something out (power, exhaust). We could ask how to measure what comes out.

I would like to find a familiar mechanism by which energy could be discussed as a weight lifted to various heights, in order to find that the units of energy seem to be the same as the units of torque. They could then find out that in one case the force and motion are colinear, while in the other way they are not.

VI. *Why are the gears of different size?*

In a four-cycle engine, the valves must operate at half engine speed because there is a power stroke every other revolution. Also, the gears must be properly assembled so that the valves open at the proper point in the cycle.

In asking this question, we want to lead the students to discover the sequence of happenings that take place in an engine, and also to learn the simple facts associated with gear operation.

The first problem, that of engine sequence, requires deduction from observation of what happens when the engine is slowly rotated – piston motion and valve motion. As aids to this observation, we can use a few cutaway engines, or simply two-dimensional engine mock-ups, or perhaps only diagrams. The type of questions that can be asked are:

1. How many teeth does each gear have?

2. How many revolutions of the small gear correspond to one revolution of the large gear?

3. What does the large gear drive?

4. Why are there bumps (cams) on the shaft?

5. What are the valves for?

6. How often must the spark plug spark?

7. Starting with the piston all the way up, can you give a name to what happens during each half-revolution of the crank-shaft? (intake, compression, firing, and exhaust strokes)

8. What will happen if you try to run the engine in reverse?

9. Could you drive the engine with an electric motor and use it as a pump?

10. Why does an engine have a "flywheel"?

11. How much gas-air mixture is "sucked" into the cylinder on each intake stroke?

12. What happens to that volume during the compression stroke?

13. What will happen if the piston rings leak?

14. How much force does it take to compress the gas?

The second problem, that of gear mechanics, can be developed with the aid of any simple gear molds on which students are able to measure input and output torque. We want them to discover that for a pair of gears, the speed ratio is determined by the ratio of the numbers of teeth and that the torque ratio is the inverse of the speed ratio, and that torque times speed is constant.

VII. *How much gasoline does an engine use?*

This question can be used to lead into discussions of simple chemistry, density of air, the concept of energy (thermal, mechanical, storage, transfer), efficiency, engine performance, and carburetor function. The discussion would be on a class basis, with the experiments in the form of demonstrations (performed by students). The types of possible questions and demonstrations are listed below:

1. How much gasoline does a car use?

2. Why gasoline rather than water?

3. What characteristic does gasoline have that makes it useful? What does it do? Flame? Heat? Pressure?

4. What part of the engine fixes the amount of gasoline that goes in? (Study carburetor needle valve and throttle valve. Demonstrate on a running engine what happens as the needle valve is opened or closed. Develop the concept of some specific ratio of gas to air. Measure intake manifold vacuum.)

5. Discuss fuel-air ratio in terms of simple chemistry, using water $2H+O - H_2O$ as an example they already know. Discuss the fact that the air nitrogen does not enter into the reaction. What does it do? Demonstrate expansion of gas with temperature.

6. Develop concept of thermal energy, and the calorie as a unit, *i.e.*, the heat transfer required to raise 1 gram of water 1° centigrade.

7. Gas and air go into the engine; what come out? We observe hot gas and shaft output. Develop First Law of Thermodynamics in simple form with a statement such as "In any device that you can run continually, all the energy that goes in must come out, *i.e.*, you never get something for nothing. Discuss what comes out of shaft is mechanical energy. (Rumfords' initial work on boring of cannons). Develop unit of mechanical energy.

8. Would we like all of the energy to come out? Develop efficiency.

9. Show experiment to measure efficiency of engine, or simply give data to groups, *i.e.*, "This engine will run for one hour on a pint of gasoline, putting out ¾ H.P."

The experiments on power should include several runs on the engines that have been reassembled. I expect that an easily understandable "Pony Brake" dynamometer can be built from which the student can determine torque-speed, power-speed, effect of carburetor and point setting. I would think that there would be only one such apparatus for each class and that the entire class would help take data, make suggestions, etc.

Experiments to Date

During the past weekend, I have crudely tried two of the above experimental approaches with my older son, who is eleven years old.

We first tried the spring experiment, in which I gave him a spring, and asked him to tell me how stiff it was, numerically, and to give me the units that go with his numbers. It was clear that a little discussion of numbers and units was necessary. I told him that in mechanical systems, we only have to use four units – lbs., inches, seconds, and °F. I used speed (in./sec.) as a familiar combination of those units. He made a simple experiment using a fish-scale and yardstick. He immediately plotted the results (probably because he has seen me plot data), and discovered a bewildering effect. All his data lay on a straight line, but it did not pass through zero. Unfortunately, I had picked up a spring which had some pre-loader initial tension! He was able to determine, with some discussion, that the units of what he calls "spring ratio" are lb./in.

In the second experiment, I gave him a coil of brass wire and asked if he could determine how strong that kind of brass was. He wasn't at all sure how he could apply information on a thin (-.010" diameter) wire, but having tested the spring, he wanted to test the wire. I suggested a piece about 50" long for the test. He soon found that, while the wire stretched in the ½ lb. range, a yardstick wasn't good enough for the measurement; so he used a millimeter scale where he estimated to the nearest ¼ mm. He took the data (I helped him to pull the scale), until fracture, and then made a plot. At several stages during the loading, I suggested that we release the load to see what happened. It was clear that, after some point, the deformation (stretch as he called it) was not all removed when the load was removed. When he made the plot, it was clear that something peculiar happened at the yield point. After some discussion, in which I asked what part of the curve would be useful for a machine part, he decided that there was indeed a load which shouldn't be exceeded. When I asked what we should call that point, he decided on "point of no return"! Having a load-stretch plot for thin wire, I then asked if he could in any way generalize the plot so that it would hold for any piece of the same material. This was too much. I then asked what would happen if he used a wire 25" long rather than 50". He said that the stretch to fracture would be ½ as large (5" compared with 10") and that the load at point of no return would be ½ as large. He then tested a 25" piece and found to his surprise that his stretch theory was correct, but the loads were just as in the 50" piece. I then asked what would happen if he pulled a piece twice as large in diameter. This was not a good question; however, when I asked what would happen if he pulled two or four pieces simultaneously, he decided that the loads would increase while the stretch remained constant. The concept of strain, elongation per initial length, came quite easily, and was termed the "stretch ratio." The concept of stress was more difficult, and was finally called the load area ratio.

I discussed with him the use of an engine for getting students interested. He thought the idea was wonderful, that all should be interested (this probably reflects his own interests pretty strongly). He also felt that they should reassemble the machine relatively soon after disassembling it, and that there should be a cutaway model available.

Systems and Processes As Units of Learning

THE new kind of education which we are envisaging in the Summer Study requires, among other things, the development of interdisciplinary units which are rooted in a child's interest and experience and which broaden the child's knowledge, enlist his reasoning power, deepen his understanding and open new vistas for exploration. A whole class of such units can be based on the analysis of systems and processes which deal with things and activities which are familiar to the youngster.

Such a very common thing is water, which for all urban and suburban dwellers is furnished and disposed of by a system. Water is familiar to children of all ages and has a fascination for most of them. The system furnishing it reaches out to so many of the disciplines into which we commonly divide our fields of knowledge and experience that it can serve as an example of the interrelatedness of all knowledge.

This is shown graphically in Fig. 1 where it is seen that the system involves the following disciplines:

1. Meteorology, hydrology and geology; actually three disciplines which are closely related in their pertinence to the present enterprise. Involved are precipitation, surface and ground water flow, and evaporation.

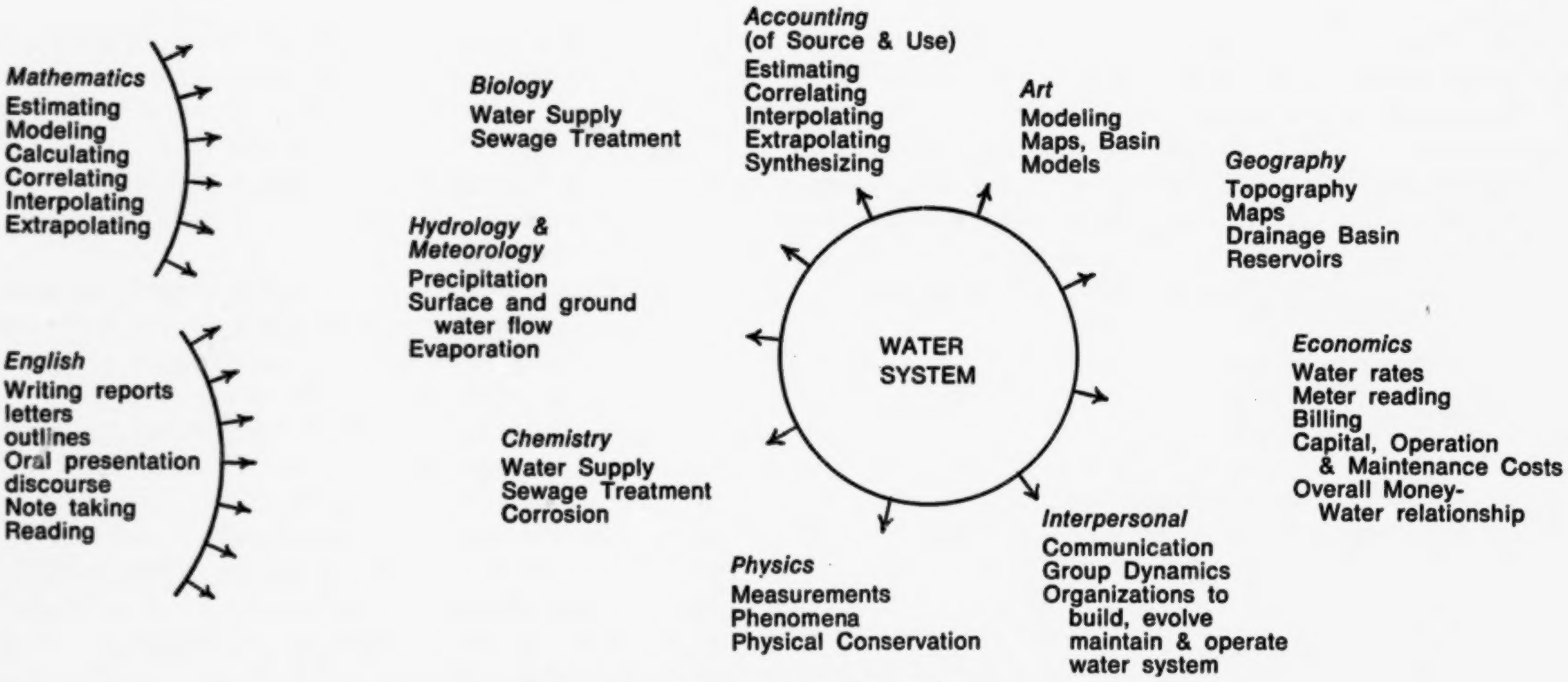

Mathematics
Estimating
Modeling
Calculating
Correlating
Interpolating
Extrapolating
English
Writing reports
letters
outlines
Oral presentation
discourse
Note taking
Reading
Biology
Water Supply
Sewage Treatment
Hydrology & Meteorology
Precipitation
Surface and ground water flow
Evaporation
Chemistry
Water Supply
Sewage Treatment
Corrosion
Accounting (of Source & Use)
Estimating
Correlating
Interpolating
Extrapolating
Synthesizing
Art
Modeling
Maps, Basin Models
Geography
Topography
Maps
Drainage Basin
Reservoirs
WATER SYSTEM
Economics
Water rates
Meter reading
Billing
Capital, Operation & Maintenance Costs
Overall Money-Water relationship
Interpersonal
Communication
Group Dynamics
Organizations to build, evolve maintain & operate water system
Physics
Measurements
Phenomena
Physical Conservation

Figure I. Interrelated Disciplines

2. Geography (also related closely to 1.) concerned with topography, drainage basin, reservoirs.

3. Chemistry
    a. of water supply: Hardness, control, chemical impurities, pipe corrosion, defloculation
    b. of sewage treatments and effluents

4. Physics — Volumes, flow rates, pressure, water accounting.

5. Biology — Water supply and sewage treatment.

6. Accounting of source and use — Estimating, correlating, interpolating, extrapolating, synthesizing.

7. Economics — Meter reading; water rates; billing; costs of capital, of depreciation, of operation and of maintenance; overall water-money relationship.

8. Personnel and management — Communication, group dynamics, organizations to build, evolve, operate and maintain system, variety of vocations.

9. Visual representation — System diagrams, maps, models of basin, etc.

10. Mathematics.

11. English.

It is apparent that a study of this system can afford exercise in many different aspects of thinking such as:

Surveying for data acquisition.
Estimating and refining estimates.
Envisaging simplifications for making analysis.
Experimenting.
Inferring.
Interpolating, extrapolating, averaging.
Comparing and correlating.

Their pertinence becomes evident when a specific learning area is examined in detail, as will be seen below.

They apply particularly if student research based on the system is undertaken. Such research might include combining individual home and family water usage levels with that of other students and extrapolating from the results the basis of a demand survey; inquiring about institutional, industrial and civic water usage; schematic mapping of home plumbing; studying neighborhood and regional topography with map interpretation and making; flow (block) diagram (abstractions) of water flow, dollar flow, etc. (*i.e.*, modeling of distribution networks, primary, secondary, house); investigating specific devices, *e.g.*, plumbing elements; experimenting with physical measurement, with chemistry, with biology, with meteorology, with hydrology.

We are confronted in Fig. 1 by a wealth of material from which, it is obvious, some choices must be made by the teacher (and students). We outline below an approach to facilitate the selection process by using a possible organization of the material. We note first, however, that a useful introduction to any specific choices is a brainstorming session in the class. In this, pupils volunteer any information, situation, phenomenon, activity, device, etc. having anything to do with the subject, which is here the water system.

These should be written on the chalk board. This brings specifics to the unified attention of the class. When suggestions begin to slow down, obvious omissions can be filled in by leading questions from the teacher.

By then arranging some of the words into suitable categories, the class can see that its own suggestions fall into areas which are logical units of exploration and from which the teacher (or the class) can choose.

A. **Distribution system**
  1. Household
  2. Neighborhood
  3. Town/city
  4. Source

B. **Economics of water supply**
  1. Money income
    a. metering
    b. billing
    c. bonds
  2. Money outgo
    a. capital outlay
    b. maintenance
    c. operation

C. **Sewerage system**
  1. House drains and drainage network
  2. City drainage network
  3. Sewage treatment plant

D. **Physical measurement**
  1. Volume
  2. Density
  3. Flow
  4. Pressure

E. **Water accounting**
  1. Income (supply)
  2. Outgo (users)
    a. residential
    b. industrial
    c. civic
  3. Losses
    a. seepage
    b. evaporation

F. **Work to be done**
  1. Design
  2. Operation
  3. Maintenance
  4. Clerical (filing, etc.)

The following are examples of how some of these categories can be explored.

A. Distribution System

A study of the distribution system might logically start in the home since the student is most familiar with this aspect. A good project for a starter is to have each student trace the plumbing in his home and make a sketch of it showing fittings and pipe diameters. The inaccessible places will create the necessity of making estimates of pipe size and where the pipes lead. The idea of estimating is felt to be most important for the students' growth in a practical world.

From the home, the study might proceed to the supply pipe that runs down the street in front of each student's home. A trip to the city engineers' office can substantiate student estimates of size and location of the pipe, the location of such things as fire hydrants and house connections, and where the supply pipe comes from and goes to.

In a large town or city it is not feasible to draw a map or plan of the complete water system of the town. However, the large main and local tanks or reservoirs and their interconnections can be investigated.

From the town, the study of the distribution system can proceed to pumping stations, treatment plants and the primary source. An investigation of the primary source involves the use of topographic maps and the study of contours and drainage basins. (Topographical maps are available in all states from the U.S. Geological Survey and are quite inexpensive.) In connection with contours, a very informative project is the making of a model of a particular valley or hill or mountain from a topographic map. Then a model of a simple drainage basin can be undertaken. In the process of making the model, the student would learn how to find drainage basin boundaries on the topographic map. After some study of these things, a field trip to visit what has been studied can be a rewarding experience and strong reinforcement of what has been learned.

Another possible area for investigation in connection with the primary source is the determination of rainfall amounts (volumes) with the aid of newspaper or U.S. Weather Bureau reports.

In any study of systems, the paths of learning will not, and should not, be entirely separate. For example, a study of water usage, water economy and the personnel operating and maintaining the system can become an integral part of the distribution-system study. In addition, water-usage estimates imply the knowledge of such physical quantities as volume, pressure and flow rate.

Examples of student projects, or questions that can easily lead to projects, for each part of the distribution system are:

1. HOUSEHOLD SYSTEM
  a. Trace the plumbing in your house and make a sketch of it, showing fittings and diameters.
  b. Estimate your family's water usage, compare with your water bill and refine your estimate.
  c. How much does water cost?
  d. How does a water meter work?
  e. How do faucets work?
  f. What are pipes made of?

g. How are pipe connections made?
h. What is a drain trap?
i. Why does the shower get hotter when the toilet is flushed?
j. Why are drain pipes so large?
k. Where does the hot water come from?
l. How does a water heater work?
m. What is a tempering valve?
n. How does a toilet flush?
o. Why doesn't the bathtub fill as quickly on the second floor as it does on the first?
p. Why does a lawn sprinkler revolve?
q. How much does the plumbing in your house cost (material/labor)?
r. How big is the inlet pipe?
s. Why is it so deep in the ground?
t. Why does it sweat in the basement?
u. Why is the inlet pipe cold, even in the summer?
v. Why is a wire from the telephone or electricity fastened to the inlet water pipe?

2. NEIGHBORHOOD SUPPLY
   a. How big do you think the supply (*not* drain) pipe along your street must be?
   b. Make a map of your neighborhood served by this pipe.
   c. How would you estimate the size of the tanks? (shadow, geometry, measuring)
   d. How much water do they hold? (mathematics)
   e. How can you tell how good your estimate is? (town records, social contact, survey)
   f. Do all of the tanks provide water to the town? (town records, survey)
   g. Relate the size of the tanks to your confirmed estimate of water usage by your town. (correlation)
   h. With normal usage, how long does it take to empty the tanks? (mathematics)
   i. Where does the water come from that fills the tanks? (survey)

3. PRIMARY RESERVOIRS (if your town gets its water from a reservoir)
   a. Does the water come from a reservoir to the tanks? (survey – make map)
   b. What makes the water flow into the tanks? gravity, alternate tracks, pumping, artesian water)
   c. How much water does the reservoir hold? (estimate area and volume from a topographic map)
   d. How long could the reservoirs supply your town?
   e. Do they also supply other towns? How much water do the other towns use?

4. RESERVOIR FILLING
   a. Where does the water come from? (rain, snow)
   b. How does the water get to the reservoir? (streams, underground, over the surface, rain or snow directly into the reservoir)
   c. Rain (snow) over what land has a chance of draining into your reservoir? (topographical map, drainage basin, contour lines, project cross-sections, build models, etc.)
   d. How much rain falls on your drainage basin and where can you get the information? (newspapers, weather reports, library)
   e. How is rainfall measured? (take field trip to weather station; investigate rain gauge)
   f. Calculate the area of your drainage basin.
   g. Compare the area of your drainage basin to the appropriate area of the rain gauges measuring the rainfall.
   h. Based on the area and the rainfall data, how much water is available to your reservoir from rain? (cubic feet, acre feet)
   i. During a rainstorm, have you observed how the rain changes from time to time and place to place?
   j. Do you think the estimate of question (h) is accurate?
   k. How much of this water actually gets to the reservoir? (see literature – hydrology books)
   l. What happens to the water that doesn't get to the reservoir?
   m. Does all of the water that gets to the reservoir reach the water system of your town?
   n. Discuss what happens to the lost water. (overflow, normal streamflow, evaporation, seepage) (Example: measure the evaporation from a drinking glass inside the class-

room and from one outside the classroom in, say, a week, etc.)

B. Economics of Water Systems

The economics of water systems can be a study in itself, or a part of a broader study. The easiest place to begin is in the cost of water to the students' own families. This involves metering, billing, basis of charges, and the physical units involved. The questions of what is done with the money paid to the city by the people and why the money is used as it is can lead the class into the economic structure of city government. Civic uses of water and the question of how the city pays for the water used in such ways as fire fighting, city fountains, and city swimming pools can also lead into the city's economic structure if desired. The economics of Water Rights is another avenue of possible investigation. Maintenance, repair, operation, design and construction present other possibilities. Samples of questions that might be asked the class to open an economic study are:

1. Does your family pay for water? How much?
2. What determines the amount to be paid?
3. How often does your family pay?
4. To whom is the money paid?
5. How does he (it?) know what to charge? (meter reading)
6. Can you check a water bill to see if it is correct?
7. By whom, do you think, are the bills made out? How is it done? Do a lot of people sit around calculating with pencil and paper?
8. How is the addressing of the billing letters done?
9. If we don't know how, can we find out? (Visit to office?) What office?
10. Does the x store pay the same as your family? Does the y factory?
11. How much in all does everybody pay?
12. What are the main kinds of tasks in supplying the water? (operating, maintenance, design and construction)
13. Are their expenses kept separate? How much are they?
14. Who gets the expense money? How much to administrators, to office workers, to laborers, to suppliers, to bond holders as interest and as principal?
15. When will the city own its water system free and clear?
16. Does the money income of the water department cover the outgo?

C. Sewerage System

Again, the logical place to begin such a study is probably in the home. The drain pipes are usually visible and easy to trace. The reason they are larger than supply pipes can lead to the study of such things as pressure, flow, density and volume if desired. Another approach is in investigation of material properties: What are the drain pipes made of and why aren't they the same as the supply pipes? If it is desirable not to branch off into side studies by the class as a whole, such studies can become individual projects. From the home the study might proceed to the streets, gutters and street drains. The students might want to find out if house drains in any way connect with street drains. This question can lead to as thorough an investigation as the class – or individuals – desire. From the city network we reach the sewage treatment plant. There is a multitude of paths that can branch off at this point – again depending on the children, the teacher and the size of the facility. Some pupils might be quite capable of going thoroughly into the chemistry or biology of sewage treatment. Others might only be interested in the actual flow paths that the water and sewage take.

Sample questions that could lead into different investigations are:

1. Where does the water go after each kind of use in your home?
    a) Flushing?
    b) Bathing?
    c) Dishwashing?
    d) Other?
2. How big are the pipes? Why are the outgoing pipes bigger than the incoming ones?
3. What is a trap and what is it for?
4. Does our town/city have two kinds of sewers? If so, why? What are they called?
5. Do sewers run downhill? (always)
6. Where does the sewage go?
7. What does the treatment plant do to it?
8. Do factories put other kinds of wastes into the sewerage system?
9. Who keeps track of the germs?
10. Who keeps track of the wastes? (What are organic wastes?)
11. What chemicals are used in a treatment plant and how are they used?

12. How does a treatment plant do what it does?
13. Is the water coming out of the treatment plant safe to drink? Why?
14. How does nature purify water?
15. What happens to the water (effluent) coming out of the treatment plant?
16. What is its effect on the stream it empties into?
17. What is done with the solid wastes?

(This material can be supplemented by having the pupils test polluted and pure water both chemically and biologically.)

D. Physical Measurements

This study can be a part of a study on water accounting, water economy, distribution system, etc., or a complete study in itself. The most fundamental concepts are volume, density, pressure and flow. These topics certainly need not be the only concepts explored, nor must they, in every case, all be considered.

If volume, density, pressure, and flow are to be considered in a single study, the volume concept is probably the most basic. Depending on the age level at which the subject is introduced, there will naturally be varying degrees of understanding of the concept of volume. The introduction can be done most effectively in a laboratory or in a room with large tables (on the order of three to four feet long). A short briefing session in class (separate from the one in which experimentation is to be done) to organize the groups is advisable. The group size should be limited to three persons, preferably two (or one) each. Individual experimentation may prove to be best, but may not be feasible. It is felt that the students should be told to leave laboratory equipment (other than that concerned with their work) alone if any such equipment happens to be in the present laboratory. They should also be told to keep a good record of everything they felt to be important in what they learn. It will probably be advantageous to pose some specific questions to be answered by the students. Insofar as is possible, the student's search for the answer should not be overly directed or overly aided by the teacher. To carry out a study of this sort, some experimental apparatus is necessary. It should be simple and inexpensive. A *sample* list of apparatus is given below.

1	**2" × 2" × 4" Aluminum block**
1	**2" × 2" × 4" Plastic block**
1	**2" × 2" × 4" Styrofoam block**
1	**2" × 3" × 4" Wood block**
8	**1" × 1" × 1" Wood blocks**
4	**1" × 1" × 4" Wood blocks**
1	**2" diam. × 4" long Aluminum or Plastic cylinder**
1	**irregular piece of iron, steel, aluminum or plastic**
1	**quart milk carton**
1	**gallon can**
1	**glass tumbler**
1	**ceramic cup**
1	**graduated (in ounces and cups) measuring cup (1 cup or 1 pint, the 1 cup being best)**
1	**quart (exact) plastic container, not graduated**
1	**cup (exact) plastic container, not graduated**
1	**graduated (500 milliliters) cylinder**
1	**1000 ml. beaker**
1	**baster, graduated in ounces**
1	**teaspoon (from set of tableware)**
1	**tablespoon (from set of tableware)**
1	**set of measuring spoons**
1	**2 lb. fish scale**
1	**1 ft. ruler**
1	**2 to 3 gallon pail, almost full of water**
1	**10" pie tin**
1	**clip board and scratch paper**
1	**available blackboard for recording results**
1	**length of string (approximately 6' long)**
1	**large sponge for cleanup**
1	**container of fairly clean sand (approximately 5 lbs.)**

For learning the measurement of volume, a procedure similar to that actually tried with a group of seventh graders (an account of which follows this report) is suggested as a sample. In a normal classroom situation, however, there could certainly be many pursuits not followed in our one short tryout. The procedure for density, as followed with the same group, is another sample possibility. Following is a possible line of questioning for volume and density experiments:

I. Volume
  - a) How do gallons and cups correspond?
  - b) What is the difference between a liquid and a solid?
  - c) How do you measure the volume of a solid? (What units, length, area, etc.)
  - d) How do you use the volume of a solid to measure the volume of a liquid? (prismatic solids, particulate non-absorbent solids (*i.e.,* sand), solids reactive in a liquid, absorbent solids (*i.e.,* sponge).
  - e) Determine conversion factors and develop a table of all of the ways to express volume (cubic inches, cubic feet, acre feet, gallons, cups, quarts, pints, teaspoons, tablespoons, fluid ounces, cubic centimeter, cubic meters, liters, etc.).
  - f) How do you measure the volume of an irregular solid?

II. Density
  - a) How much does a gallon of water weigh?
  - b) How much does a cup of water weigh?
  - c) How much do the solid bodies weigh?
  - d) Express the weight-volume relationships for the solids and liquids and show the results in a table.
  - e) What is the difference between an ounce of weight and an ounce of volume?

For measurement of flow, the relationship between volume and time can be established by timing the filling of a gallon can. The flow rate in gallons per second can then be calculated An exercise in change of units to cubic inches per second might at this time be beneficial. To understand the meaning of pressure, a plexiglass cylinder is a possible vehicle. Holes are drilled at different levels with approximately 1" long plexiglass tubes glued out from the holes. Plastic tubing can then easily be slipped over the protruding plexiglass tubes.

Samples of some of the questions that lead to experimental findings are:

III. Flow
  - a) How long does it take to fill a gallon can from a:
    - 1) Wide open faucet?
    - 2) Dripping faucet (use a cup and then calculate)?
    - 3) Fire hose and hydrant?
  - b) Express the above discharge rates in appropriate units. (gallons per minute, ounces per minute, ounces per second, cubic inches per second, cubic inches per minute).
  - c) If you know the volume flow (rate) of a liquid, how do you determine the weight flow (rate)?
  - d) How would you determine weight flow (rate) directly?
  - e) How many ways that you have seen flow measured can you list?
  - f) In each case, how was the measurement accomplished?

IV. Pressure
  - a) Is the flow rate of a liquid different out of two holes, one near the top of a tank and one near the bottom? (measure it)
  - b) To what do you attribute any differences?
  - c) Plug the holes with a piece of flexible, transparent tubing and observe the water level in each tube for different tube arrangements.
  - d) Which distance is always the same? (vertical)
  - e) What is the weight of water in that distance for each hole (vertical column of water from hole to surface)?
  - f) Put oil tank in the tubes and connect them to the tank of water at the holes, measure the weight of the oil in the tube. Compare to the water weight.
  - g) What is the relationship between the weight of water and oil, and the vertical distance from the surface of the water to the hole?
  - h) What happens (in d, e, f, g) if you change the diameter of the tube?
  - i) What is the relationship between the cross-sectional area of the tube and the weight of the water or oil column for each hole with different sized tubes?
  - j) In what units would you express the relationship?
  - k) What other pressure measuring devices are you familiar with? (tire gage, bourdon gage, etc.)
  - l) How do they work?

E. Over-all Water Accounting

In all systems involving measurable quantities of materials or money, it is wise to match the amount of any such component which leaves the system in any form with the amount which enters it in any form. Sometimes this flow through the system can be measured at other points. This applies to the water in a water system. (It also applies to the money flow, which is the subject of another section.) An intermediate partial check can be based on the metered volumes of water "consumed" by various users.

Although the students can make some guesses from their own measurements and from handbook information for plumbing design and information from various industries, the definitive data will be found in reports of the department of water supply and of the sewerage system. Water uses which may involve unaccounted-for escape of water from the system are fire fighting, street cleaning, evaporation, lawn sprinkling, leaks in water mains, and some chemical processes. An interview with one of the engineers in the water system can throw additional light on this problem.

Some questions which can lead to an understanding of the problem follow. A few imply measurements by the students themselves.

1. What household uses do not remove water from the water system as a whole? Explain.
2. Which do? Explain.
3. Which items in the list lose water from the system? Explain.
4. Do we get to use all the water in the primary reservoir?
5. All the water pumped from the wells?
6. All the water that falls in the drainage basin?
7. How are the various quantities measured?
8. How do we lose it?
9. What checks do we have?
10. How much water is lost by a leaky faucet? How fast does water evaporate?
11. How nearly does the volume of water leaving the primary reservoir check with the volume of sewage treated?
12. How nearly can the difference be accounted for?

A natural adjunct to the water accounting study is a detailed study on *water usage.* The following questions, plus many others already posed in the *"Distribution System"* are representative samples of the types of questions that could be meaningful.

1. How are we going to determine how much water our town uses?
2. Who uses water in our town? (residential, industrial, civic)
3. How will we estimate the residential usage of water?
4. Itemize the residential users.
5. How do people in houses use water? (drink, bathe, wash dishes, wash clothes, wash hands, cook, wash car, water lawns, garden, swimming pool, sprinklers, etc.)
6. How are we going to determine how much water is used in the home? (meter, if you have one)
7. Without water meters how could you estimate how much water is used in your home?
8. How would you estimate how much water a person drinks? uses in bathing? uses in cooking? uses in lawn sprinkling? etc.? Design experiments to provide data with which to establish the estimates.
9. Design a survey, including forms, to be used by each class member in estimating his family's water use.
10. Over how long a time do you need to collect information on which to base your estimates?
11. Study the data collected by your classmates.
12. What are the ranges of water usage in a single category (*i.e.*, drinking, bathing, etc.) among the data collected?
13. What are the averages of the data?

F. Personnel and Interviewing

Apart from the various technical and financial aspects of the water system are the people who, one way or another, participate in it and who have technical and organizational information about its operation. Organizationally they work in various groups which carry out separate but still interrelated functions. There is a hierarchy of responsibility reading up from superintendents and plant operators through the chief engineer (who may have a different title) to the mayor or city manager or other top political official. The functions and relationships of the jobs of these people form a legitimate subject of study which can be put on what is effectively an experimental basis by having the pupils get the information by direct interviews. This will be a novel and rewarding experience. The group interviewing one person should not be large, maybe five or six.

There follows a list of appropriate people to interview which may need amending in any specific case. Brackets indicate an instruction or comment for the teacher's attention and a list of possible interview questions.

PERSONNEL

City Manager
Chief Engineer-Superintendent of Public Works
Plant Operators: Pumping, Filtration, Sewage
Superintendent of Maintenance-Water Inspectors
Chemists
Biologists
Conservationist
Security Chief (police?)
Laborers
Pipe Wranglers
Power Equipment Operators
Chief Clerk
Meter Readers
Billers

Accountants
Auditors

INTERVIEW PLANNING

Whom do we go to see? (Children suggest. Ask leading questions to develop list.)

Whom do we see first? (Answer) Why? (Start at top of list.)

How do you explain what you are about?

What do we expect to get from him?

How will you go about setting up interview?

Hazards of just going to office.

Disadvantages of telephone — secretary block, immediate scheduling, disparity of age, etc.

Write a letter. (Should there be a tip-off?)

How many for interview? Who in group?

How specific a list of questions should children have in hand?

INTERVIEWING

What do you wear to an interview?

How do you address the interviewee?

Who does the talking? (Leader needed)

Should teacher go? (No)

How do you remember the answers? (Take notes) Everybody?

Suppose interviewee doesn't *really* answer question? (How persistent are you?) Can somebody else on list answer it?

What if interviewee diverges from your questions? Is what he says relevant to what you actually want to know? (If so, note that a project must be successively reformulated as new resources are tapped.)

How do you budget your time to be sure all your questions are asked?

How do you end an interview?

INTERVIEW REVIEWING

How did it go? Did he cooperate? What should we do differently next time? Was the questioning systematic and effective?

What were the answers to 1, 2, 3 . . . n? Do we agree with each other? What answers are missing? How come?

How do the answers compare with our estimates? What do we learn from discrepancies?

Did we get more than we asked for? What do we do with it? Throw it away? Report it? Use it in preparing for succeeding interviews?

What should we do next? Report? Another interview? Field trip? Reference work? Bring project record up to date?

What do we report? Format? Tables? Description? Pictures?

Whom do we interview next? Why?

INTERVIEW QUESTIONS

What people are involved in operating a water system?

How did each one get there? How long has he been there?

Education?
Training?
Exam?
Civil Service?
Political Appointment?

What does he (each one) do?

How does this job fit into the overall picture? Does he get wet?

Who is his supervisor and what does his supervisor do for him? What decisions does/can he make?

Whom does he manage? What do they do? What does he do for them?

What equipment does he use and who builds it? (How much does his equipment cost? How old is it? Should it be replaced?)

What are his working conditions?

Hours? Week?
Vacation?
Overtime — emergency?
Sick Leave?
Pension?
Health Insurance?
Salary or Wages, Increase Policy?
Does he belong to a union?

Make an organizational chart of the people involved and compare with the official chart. (City Engineer's Office)

What does he need to know about the system (size, organization, operation)?

How does he know what he knows about the system?

Where does the water department stop?

What can go wrong in a water system?

What emergencies occur in a water system?

How is an emergency discovered or recognized?

What is done about it? By whom? When?

Are routine repairs the same as maintenance?

A Limited Class Experience With The Water Distribution System And Physical Measurements

For the purpose of testing the ideas outlined above, we have chosen two of the multiplicity of areas as being illustrative, namely: 1) the general supply branch of the system, 2) the technique of physical measurement of volume, flow, density, and pressure. These two were tried with a group of nine seventh grade boys for far too short a time. What happened will now be told. The approaches, by elementary-classroom amateurs, must be considered as purely suggestive; the pupil reaction is often out of even the professional's hands.

Map Study and Field Trip

The water system under study was that of the city of Cambridge, Mass. It had been determined that complete coverage required six contiguous U.S. Geological Survey maps, and we had four sets on hand besides an already prepared composite map. This had been used for our own instruction but was not used with the class.

The class was held in a room with sufficient table-top space available to spread out all four of the student maps. Prof. Leonard Baldwin conducted the class. He first listed the names of the boys on the front blackboard. He then explained that the class was going to talk and learn about water, where it came from and what one could do with it. He called for ideas about what water was like, its uses, where it came from, etc. After about thirty minutes of suggestions and discussion the board carried a list of some forty items. Then Prof. Baldwin began by questions (Where does our water come from? How did it get there? Where does it go then? How?, etc.) to develop the flow chart for the system on the blackboard through the complete cycle, including evaporation and rain and snow. Strangely, many of the boys thought that the effluent from the sewage-treatment plant went into the primary reservoir!

With the scheme of the system before them, the boys were led to classify the blackboard items according to the part of the system they belonged to – supply, household usage, industrial usage, other, sewerage.

Then the map of the Cambridge section was given to the boys and Prof. Robert Mann and Dr. Lewi Tonks began to take an active part in the examination by the boys. They readily found the locations of their houses where street names appeared on the map, and even where names were missing they still found it possible.

Each group was then given the other five maps. There were varying degrees of aptitude in determining how the maps fitted. No group used the section names bordering the mapped rectangle to make the correct selection, nor did they use the latitude and longitude designations. (At no time did we refer to these and explore their significance.) The boys relied entirely on the fitting of geographic features such as roads, streams and map coloring. The boys joined the maps by folding back borders and/or cutting them off and then using scotch tape.

The composite map was used to identify Cambridge Reservoir, Stony Brook Reservoir, and Fresh Pond. The implications of their relative levels for flow were discussed – also the consequence of Fresh Pond being two feet above mean sea level. Contour lines and streams contributing to Cambridge Reservoir were identified and discussed. Hobbs Brook from Cambridge Reservoir to Stony Brook Reservoir was traced. The probable course of the main supply pipe from Fresh Pond was pondered.

Before disbanding, the class was shown the route of the afternoon trip around Cambridge Reservoir, past the lower end of Stony Brook Reservoir and to Fresh Pond.

This activity took about an hour and a half, and it was apparent that this was straining their attention span. For the final quarter hour of this time their attention was increasingly taken by some model gear trains stored on a shelf, and more and more they played at either grinding up chalk or corrugating the border strips cut from the maps.

The class was dismissed at 10:30 a.m.

At 11:30 the group reassembled to go by bus to Beaver Brook Picnic Ground where we ate box lunches. As we traveled along the bank, I observed little reaction to the extremely low level of the water either here or at the dam at the southern end. The boys clambered down the south face of the dam to Hobb's Creek, which was carrying a considerable volume of water.

In seeking the Stony Brook Dam we came upon the Viking Monument, which the boys enjoyed climbing. In retrospect we lost an opportunity to talk about the Vikings, their long sea voyages, Greenland, and their open ships.

At Stony Brook Dam there was the expected tossing of stones for the splashes, or for the joy of throwing, but some of the boys were interested in noting the flow of water in the effluent channel, even though the velocity was low. They noted a ripple pattern extending out from an uneveness in the channel wall and the slow motion of a floating stick.

Finally we visited the treatment plant and pumping station at Fresh Pond. They had noted the open flow out of Stony Brook Reservoir but had not seen where the stream went underground; here they saw underfoot through a grill the T of 48" iron pipe by which water came from Stony Brook and was either stored in Fresh Pond or was passed on to be treated. Successively they visited the liming rooms, walked over the several underground reservoirs where the water was defloculated with alum, entered the main building past the array of sand-and-charcoal filters, saw the sampling stand at which water samples could be withdrawn at various stages of treatment, went into the chlorinating room where they came upon a flow-chart representation akin to the one which had been developed in the classroom, and on to the pump where two 12-million-gallon-per-day pumps were handling the normal 24-million-gallon-per-day output of the plant. A third pump was in reserve.

Dr. Tonks held a short review of the trip two days later, when we met the boys again. This showed that they had absorbed a fair amount from their map work and from what they had seen at the Fresh Pond station. In retrospect we could have done better with more experience and time.

The meaning of the contour lines on the map remained vague and confusing to at least one of the boys. Actual topographic models are needed for full understanding. We didn't scale any distances. We didn't find out what the colors green and white over an area meant. An excursion should be thoroughly scouted beforehand and arrangements made to get access to control gates. We should have had pictures of the reservoirs full for contrast. The treatment plant visit should have been supplemented with cutaway views of a limer, and a big valve (maybe an operating model).

Following the session with Dr. Tonks, the students then went into the Engineering Projects Laboratory at M.I.T. at about 10:15 a.m. to do some experimentation on volume and density. They were divided into three groups, each at a separate table. It was felt that the maximum workable group size was three persons. Prof. Baldwin, Prof. Mann and Dr. Tonks observed and assisted at one table each. It became evident during the course of the experimentation that one teacher alone could handle more than three groups with four or five being a probable maximum.

Each group found, upon reaching its table:

1	2" × 2" × 4" aluminum block
1	2" × 2" × 4" plastic block
1	2" × 2" × 4" wood block
8	1" × 1" × 4" long aluminum cylinder
1	irregular piece of steel with a volume of several cubic inches
1	12 inch ruler
1	pint graduated (in ounces) measuring cup
1	ceramic drinking cup (*not* exactly 1 cup when full)
1	plastic 1 cup container (not graduated)
1	qt. milk carton
1	gallon can
1	2 to 3 gallon pail almost full of water
1	qt. plastic container, not graduated but exactly 1 qt. when full to the top
1	#2 ½ tin can
1	2 lb. fish scale
1	10 inch pie tin
1	clip board and scratch paper
1	blackboard for recording results
1	graduated baster
1	large sponge

The first question posed to the groups was: How big is a cup compared to an ounce? Some of the students immediately spotted the pint graduated in ounces with cups plainly marked on the side. The information quickly passed on to the entire class. How big is a gallon compared to a cup? To an ounce? These questions brought forth measurements with the measuring cup *and* with the drinking cup. After some discussion it became apparent that for consistency the measuring cup should be used for all comparisons. The ounces were easy because of the graduated pint. The students were asked to be careful to record all of their findings on the blackboard. They were unable, upon being asked, to show the relationship between gallons, ounces and cups in a table until the form of the table was suggested to them. Filling in the blanks was easy for one or two but hard for others.

The questions, what is a volume? How can we describe a particular volume? Do we always have to fill something up? What about a solid?, evoked considerable discussion. Some of the students knew about volume and how to find the volume of rectangular blocks. Others didn't have the slightest idea. At this point some time had to be spent with the one-inch cubes, the 1" x 1" x 4" wood blocks and the aluminum and plastic blocks before the concept of volume was fairly well understood. Two or three students never were completely sure how to calculate the volume of a rectangular block, but they could all find the volume by stacking up the one-inch cubes alongside. At this point, it was reasonably certain that, for example, a 2" x 3" x 4½" block would have baffled some of them. In retrospect, it is believed that the concept of volume could have been learned by all of them in a normal classroom taking things at a slower pace.

The conversion from cubic inches to ounces, cups and gallons was probably the toughest task of the day. At just about the time they faced this problem it was decided to end the morning sessions. The time was approximately 11:30 a.m.

The students returned at 2:00 p.m. and resumed their projects.

The big problem with the conversion from cubic inches to ounces lay in their arithmetic as well as in their being unable to find out how much space their sixteen cubic inch blocks took up in ounces. One student came up with the idea of using some aluminum foil to form the shape of those blocks, then to fill it with water, then to pour the water into a measuring cup in order to find out how many ounces. "Too bad – no aluminum foil – it probably would have bulged too much anyway." Finally, two boys in the class (at different tables) were able to come up with the idea that if they filled their quart plastic containers, then inserted the aluminum block and collected the overflow, they could find out how many ounces occupied the same space as sixteen cubic inches. Once the discovery had been made, his group and one other quickly joined in and found the volume (in ounces) of the aluminum cylinder and an irregular steel object. The number of ounces equivalent to sixteen cubic inches had not been too difficult, but the arithmetic required to find the number of cubic inches in the cylinder and in the irregular object was beyond them. They were still enthusiastic at this point, however, and only needed a little help to get on the right track. Cubic inches were then added to the table showing the relation between ounces, cups and gallons. The full conversion was finally accomplished by two of the three groups.

The subject was then changed to density, and the students were asked to weigh their solid bodies. This posed no problem except that they found their scales to be calibrated in ounces. For a while they were thoroughly confused with ounces of weight as compared to ounces of volume.

Again, in retrospect, it seems that more time should be spent in finding out the difference. One group was able to find the number of ounces (weight) per cubic inch of their solid bodies. Another group was able to find the number of ounces (weight) of water per quart but did not get to the ounces per cubic inch of water or the solids. The third group had not quite reached the weighing stage when the session was called to a halt at 3:30 p.m.

One boy in the fastest group became involved in a side issue when he decided that the amount of liquid displaced by a solid body depended on the weight of the body. After some experimentation, on his own, he was able to convince himself of the wrongness of his first decision.

It is important to note that: 1) The students were engrossed in the experimentation for a period of 1½ hours without a break for both morning and afternoon sessions. The one exception to this statement was one boy who complained of a stomach ache about half an hour before the close of the afternoon session and didn't contribute appreciably after that time. 2) At least one boy who did not express himself well verbally, and who had trouble with arithmetic, was able to discover rather quickly ways of making measurements and to perform laboratory operations ably. 3) Several boys took pride in being able to come up with ideas on their own and wanted to be the first to find the answer.

Sample Program on Boats

BOATS could be chosen as a topic for study because they arouse natural student interest and lend themselves quite easily to an interdisciplinary approach to learning. Various facets of the study of boats can become vehicles for meaningful student experiences which can lead, in turn, to the desire to explore and to a deeper understanding of the world around them.

This project was first conceived as a laboratory-oriented course for learning such physical concepts as density, buoyancy, stability, velocity and drag. It soon became apparent that the implications were much greater than originally envisioned.

In an actual classroom situation a brainstorming session can quickly lead to many ways of categorizing learning areas which might lend themselves to individual and class projects. For example, the question: "What do you think of when the word 'boat' is mentioned?" might bring out such things as:

sailboats
rowboats
hydroplanes
canoes
outriggers
motorboats
air boats
ocean liners
house boats
ferryboats
steamboats
destroyers
battleships
whale boat
fishing boat
sailors
captains
stevedores

rafts
tugboats
barnacles
waves
boat pictures
explorers
icebreakers
waterskiing
surfboarding
paddleboats
cargo ships
aircraft carriers
rivers
submarines
boat designers
yacht
power
speed

navy
boatbuilders
water
sea songs
boat models
rust
pitching
yawing
seasickness
skindiving
tides
harbors
storms
hurricanes
wind
rain
passengers
Vikings

The different types of boats could be classed according to uses, size, type, speed, number of passengers and freight capacity.

The interdisciplinary nature of the topic "boats" and several areas for possible study are given below.

1. *Art*
   Modeling, drawing, painting
2. *Biology*
   Barnacles, marine borers
3. *Chemistry*
   Rust, corrosion
4. *Economics*
   Operating, maintenance, and capital costs, freight, passengers, money income and outgo
5. *English*
   Report writing, letter writing
6. *Geography*
   Shipping lanes, battle sites, trade, maps
7. *History*
   Evolution of warships, whalers, battles
8. *Materials*
   Wood, steel, fiberglas, aluminum, strength, properties
9. *Mathematics*
   Would evolve from any or all areas
10. *Meteorology*
    Wind, rain, storms, hurricanes
11. *Music*
    Sea songs and chants
12. *Physics*
    Density, buoyancy, waves, power, drag
13. *Social Studies*
    Group dynamics, interviews, people involved in design, maintenance, operation

If we select one of the above categories for study, for example physics, there are many techniques by which the subject might be introduced. Some *suggestions* are:

1. Trip to see a boat.
2. Trip on a boat.
3. Boats in a pool in the classroom.
4. Movie about boats.

Some of these techniques may not be possible, but the movie is thought to be essential. The movie could contain scenes illustrating the following:

1. Types of boats (speedboat, ocean liner, aircraft carrier, hydroplane, hydrofoil, sailboat, etc.)
2. Wake in placid water.
3. Destroyer in a heavy storm.
4. Man standing in a canoe which capsizes.
5. Boat sinking.

The last scene was included to lead into:

1. Why does a boat float?
    a. What is a boat made of?
    b. Can you build a solid boat?
    c. Why does wood float?
    d. Why does iron sink?
    e. Why can you make a boat of iron?
    f. How can you determine numerically whether a material floats or sinks? (Provide blocks of varying density)
2. Why can boats tip over?
    a. What can happen when you stand up in a canoe? (Provide a boat and a movable weight. What happens if the weight is at the top of a mast? in the middle of a mast?, etc. Choose boat and weight such that the boat capsizes when the weight is at the top of the mast but does not when the weight is low on the mast.)
    b. What effect does the shape of a boat have on its tipping?
    c. What effect does the size of a boat have on its tipping?
    Why do some boats have keels?
    e. How can you make a boat tip?
    f. When you tip a boat how long does it take to right itself? (Develop the idea of frequency of roll; move a weight to different points on a mast; graph frequency vs. position of weight.)
    g. Can you stop a boat from rolling?
    h. What happens if you mount a gyroscope on a boat?
    i. How far do sailboats tip?
    j. Can waves make a boat tip over?
3. How fast can boats go?
    (Provide students with a boat, a towing tank around 8 feet long, and a cord-pulley-weight arrangement for towing the boat.)
    a. How do you measure the speed?
    b. How does the speed vary with the force pulling the boat?
    c. What holds the boat back while you are towing it?
    d. Would it be harder to pull the boat through molasses?

The above questions are intended only as samples of how the study might proceed. It is felt that this type of questioning can lead to a great amount of student interest and student involvement.

Other topics, still physical in nature, that might be interesting to pursue are:

1. Sailboats, airfoils, compressibility
2. Motion of a boat in a current
    (relative velocities, rate-time-distance problems)
3. Tides — Why do they occur? How do they affect a harbor? etc. Ex: Bay of Fundy
4. Submarines and hydrofoils
5. Surfboards
6. Water skiing
7. Behavior of water as an incompressible fluid
8. Suppose oceans were made of molasses. What would be the effect on boat design, forces, etc.?

Sample Program on Electricity

THE following is a proposal of how the concepts of electricity may be introduced to the students of junior high school age. The proposal, intended to be only a framework, is based upon the belief that it is the teachers' responsibility to capitalize on the environment in which they (the teacher and students) are working. Hence, in keeping with the idea of an integrated form of teaching, teams of teachers working closely with the home and industry could well work together in developing the overall subject.

By the use of the electrical system comprising the students' homes, neighborhood, city and source of electricity, an appeal is made to real experience which involves the student. By such involvement, he acquires a responsibility to the class, and hence to himself, enhancing his interest and desire to continue learning. For example, in determining the peak electrical loads for a neighborhood, it could be each child's project to record the amount of electrical energy used over a given period of time in his home, and then to report this so that it may be combined with the results of his fellow students. To complete this particular study, groups of students can be assigned the task of collecting relative information from those industries located within the community. From this one example one can see that the subject itself need not be taught only in the school, but rather within the community, involving parents and members of industry.

One often hears that the subject of electricity has an abstract nature. However, electricity can become tangible. By placing in the students' own hands simple, reliable equipment, they can gain an understanding of this phenomenon. By designing experiments for this purpose, the teacher should be able to place the student in the position of asking "How?" and "Why?", and have the equipment help answer these questions.

The following outline is an indication of some of the areas in which the student is directly involved and where the concepts of electricity can be introduced.

Outline

Starting in the home, the student is exposed to electric circuits. By constructing simple model circuits and working with them, the student can build up experience with:

a. Circuits – series and parallel (the advantage and disadvantage of each); switches

b. Electric conductivity – basic electrical ideas (current, resistance, voltage) and materials (conductors, non-conductors, semi-conductors)

c. Electrical measurement – meters, Ohm's law (by graphical analysis), effect of length and cross-sectional area on resistance

d. Cost of electricity – meters, study of appliances. (Items such as a toaster and radio could well be in the laboratory and made available to the students for experimentation.)

Looking at the larger community, as well as the above, the student can also become involved in and learn more from the following:

a. Social interaction of people

b. Jobs connected to the electrical system, job opportunities

c. Mutual interaction between cities in event of emergency, blackout, causes of blackout, lightning, leads into static electricity, the atomic model

d. Problems of design

e. Transformer – A.C. and D.C. current; energy distribution; electric motors.

Another component of the system is its actual source. Here, students become involved in:

a. Generation of electricity
    water – topography
    steam
    chemical
    crystal (in a record player)
    nuclear – atomic structure

b. Relation of population centers to source

c. Transmission and transmission towers – structure

d. Economy

The above is only an outline; it can be further developed for integrated teaching in much the same way as the water system. For example, letters will have to be written, interviews carried out, reports made on interviews, maps drawn, mathematics developed as needed, and many other activities can develop to relate a variety of disciplines to the project.

Sample Project on Currency and Finance

Introduction

A. Display some things that through the years have been used as mediums of exchange: jewelry, furs, food stuffs, etc.

Have students suggest other things that could also be used.

Some pupils might have coin collections which they could show and discuss.

B. Questions:
   1. Why are mediums of exchange necessary?
   2. What mediums of exchange do we use today?
   3. Why do we use what we do?
   4. How does gold relate to our money?
   5. Why don't we use gold coins?
   6. What makes gold valuable?
   7. What is a "gold standard"?

Some Objectives

A. Understanding of how money came to be used as a medium of exchange.
B. Relationship of gold and silver to paper currency and coins.
C. Knowledge of the use of checks in place of money.
D. Knowledge of the use of credit in our economy.
E. Understanding of the various lending institutions in the community.
F. Learning how to estimate costs and plan a budget.

Projects

A. Using iron pyrite, "pan" for "gold" in the way of early prospectors.
B. Design and build a usable coin counter (for rolls of pennies, nickels, dimes, etc.)
C. Plan a trip (or several trips by different groups of pupils)
   1. Use of traveler's checks, personal checks, letter of credit, etc.
   2. Study transportation facilities.
   3. Plan a budget.
   4. Set up itinerary.
   5. Compare costs of camping out with motel-hotel living.
D. Give simulated checkbook to each student or group of students and have them "write" checks for expenses of trip.
E. While trip is in progress, teacher might set up difficulties along the way for students to solve: *i.e.*, car breaks down, planes get grounded, living accommodations cost more than planned, etc.
F. Compare "travel now – pay later" plans.
   1. Find out interest rates on loans from finance companies *vs.* banks.
   2. Will banks lend money for a trip? What things will they lend for?
   3. Comparison of money-lending institutions.
G. How might credit cards be used?
   1. Advantages?
   2. Disadvantages?

Relationship of Project to Other Courses

A. English
   1. Read books on "gold rush" days.
   2. Write report of trip.
B. Social Studies
   1. Study gold standard and Federal Reserve system, balance of payments, etc.
   2. Find out about place visited on trip: Geographical location, terrain, industries, economy, etc.
   3. Send for materials from Chamber of Commerce, newspapers, etc.
C. Math
   1. Graph percentages of money to be used for shelter, food, traveling, etc.
   2. Compute estimated mileage and costs of operating car for trip.
   3. Chart comparative costs of different methods of transportation.
D. Science
   1. Study of metals.
   2. Extracting "fool's gold."
E. Homemaking
   1. What clothes are necessary?
   2. Would these differ if traveling by plane, car, or train?
F. Industrial arts
   1. Build coin counter
   2. Build insulated chest for keeping perishable foods (One way to cut cost of trip would be to carry food for some meals.)

TEACHER EDUCATION

FINAL GROUP REPORT

DURING the M.I.T. Summer Study of the feasibility of developing a program to improve the effectiveness and to recast current practices in vocational and technical education on a national scale, it became apparent that students in our junior and senior high schools must be introduced to the broad spectrum of doing and thinking. This approach is necessary in order to eliminate the growing discontinuity between scientific knowledge and social development. It was the considered judgment of the participants that course content needs to be selected from a "new" point of view, and that methods of teaching must be those that will develop intellectual competence and educational self-direction.

We noted that since the time of Newton, new knowledge has increased by a factor of one million, and each year one hundred thousand research studies are published reporting new ideas or refinements of the old. The pace at which new knowledge is generated shows no sign of leveling off, but indicates an acceleration which will require students leaving our high schools to face a turnover of new knowledge in their respective fields of two to three times during their production life.

At the same time, the time allocated to the teaching of science in our conventional high schools has not changed from the standard 150 hours per year. New scientific achievements are taught by increasing the size of text books, adding more homework, and memorizing massive doses of facts without conceptual order. Without the process of inquiry to unify what is being learned, facts are left dangling without place in the overall scheme of things.

We held the conviction that learning is truly accurate only to the degree that the student has the opportunity for true experience with three-dimensional objects, materials, and/or the phenomena of the system under study.

Education must enable young people to participate in careers today and in the new world of tomorrow. Twenty-six million young people will enter the labor force during the period from 1960 to 1970. Their aptitudes, skills and education must match the needs of a changing economy. The eight out of ten who do not complete college must gain occupational competence and technical education in future-oriented programs in secondary and post-secondary schools. Current practices in education have resulted in the paradox of four million people on the unemployment rolls of the nation and five million unfilled job opportunities which combine to result in a loss to the economy of this nation of sixteen billion dollars in wages each year. The largest unemployed group is the 16-21 age group made up of recent high school graduates and dropouts.

Teacher education, in-service training, and pre-service training in interdisciplinary skills are needed to make it possible for all communities to offer diversified vocational or technical courses to all students in the secondary and post secondary schools of the nation. The teacher education group of the summer study has outlined in this report three proposed programs for teachers on the following levels: An in-service teacher education program; a pre-service teacher education program; and a program of preparation for post high school teachers.

Several general assumptions formed the basis of the work which followed. The group agreed that at the present time most teachers are trained and teach as specialists. All planning of future teacher training programs (in-service and pre-service) would have to be approached from the multidisciplinary or interdisciplinary concept to accomplish the goals of the new program. We felt that occupational instruction should be initiated at the seventh-grade level for all students. The instruction should be broadly based rather than highly specialized. This general occupational instruction should become more specialized at the thirteenth and fourteenth years of schooling. And finally, we were aware of the probable necessity of utilizing many facilities and resources outside of the traditional colleges of education for teacher training services.

Preliminary Planning

Teacher education for a changing curriculum must have guidelines to direct in-service and pre-service programs. The basic purpose of all teacher training will be to prepare teachers to handle the content and method of the new course work, much of which has not yet been developed. In general, the details of what is to be learned and how it can be effectively presented to students can best be developed by experienced teachers with assistance from top-level people in industrial, scientific, and other professions.

In order to give direction and support to teacher education services, groups of experienced teachers from selected fields of study should be brought together to develop the content and method of instruction required for an interrelated sequence of studies for grades seven through twelve based on the recommendations of the 1965 M.I.T. Summer Study. Teachers from the various educational areas would enumerate the specific competencies required for teachers in multidisciplinary instructional programs, and suggest ways and means for teacher recruitment and training. In the area of industrial occupations, for example, a developmental group might consist of science, mathematics, and English teachers, industrial and practical arts or technology teachers, and one or more professionals from areas of industry, the sciences, engineering, and social sciences.

Teachers should be selected carefully for a developmental group of this nature. Ideally, they should have demonstrated skill in developing or working in multidisciplinary courses and programs. People from professional fields outside of the school should be chosen for their depth of knowledge in specialized fields to insure that depth of understanding is not sacrificed as the course work is broadened and that up-to-date ideas are brought into the planning process.

Basically this group should develop examples of the course material to be taught, using the team approach for both the classroom and the shop or laboratory. The theory must be derived from experiences. Techniques must be worked out to facilitate teaching while working with things. The study of application as a means to the understanding of theory is necessary. Other groups of teachers might be brought together to develop interrelations of subject matter in the fields of health, business, social sciences, political sciences, art, music, etc.

In-Service Teacher Education

Teachers who have been accustomed to teaching in a single subject field such as mathematics, shop, or English will need special training to function effectively in a multidisciplinary program. The necessary training may be provided in several ways: summer institutes, evening courses, or special academic year institutes. These special training courses can be provided on a university campus or in schools such as technical institutes, community colleges or area vocational-technical schools. It may be advantageous, in some cases, to conduct teacher-training programs in high schools where an on-going program will provide a laboratory for the teachers' use. A system for both graduate and undergraduate credit must be provided for each type of training course. Other requirements of in-service training are financial support for the program operation and stipends for participating teachers.

In determining program content it is recommended that only the general parameters of the training be established. These elements might include certain minimum requirements for competence in each of the study fields or disciplines involved. In general, however, the outcome of the training will be apparent only to the extent that interdisciplinary learning and planning result. By bringing together materials from each discipline, units of instruction will be developed which provide concrete examples of interdisciplinary learning. Information of a specific nature, such as occupational requirements, trends in manpower utilization and demonstrations of special teaching techniques may be provided by people outside the primary teaching staff of the training programs.

The in-service teacher education program should be designed to do three things: First, it must bring teachers from selected subject matter areas together in a planned program. The subject areas should be those in which it is planned to develop interrelated courses. Second, the program must familiarize teachers from each subject field with the related subject fields. And last, the program should provide a means for all teachers to work together in developing an interdisciplinary instructional program with facilities for preparing, testing, and revising units of instruction.

A program designed to meet these objectives will require experienced leadership to plan and conduct each aspect. It is mandatory that staff personnel of any in-service training program have experience in interdisciplinary instructional programs, and experience in industry or business may be extremely valuable. The instructional staff of any in-service training program should include one person from each field of study represented in the interdisciplinary instructional program. This composition is especially necessary in summer institutes where the instruction will include study in each field as well as developmental work of interrelating the separate fields.

In addition to the primary staff of experienced teachers, teachers with experience in some of the new curriculum materials, industrialists, sociologists, labor market specialists, and representatives of the professions should be utilized.

Participant selection is a major consideration in the planning and operation of a program of in-service training. The primary criteria for determining who should participate in special institutes, courses or other in-service programs should be assessments of individual capacity for leadership in developing new programs. In addition, however, some indication of the individual's teaching assignment in the future will be required. Wherever possible, there should be evidence that administrative support will be provided – a commitment on the part of the teacher's employing institution.

The program of in-service training schools or courses, whether summer institute, evening classes or academic year schools, would begin with participant orientation by means of an introduction to interdisciplinary learning with demonstrations of instructional units that utilize all disciplines. In this way the staff could determine individual needs and provide for them within the disciplines by scheduling discrete classes in each discipline and arranging special sessions for those who want additional instruction.

The schedule of courses, group planning and developmental study in the laboratory should be flexible in order to allow for the best use of each. Below is a typical seven-hour daily schedule for a summer institute:

1st & 2nd Hour	3rd & 4th Hour	3-Hour Period
Combinations of Special Disciplines	GROUP PLANNING	DEVELOPMENTAL LAB
Combinations of Special Disciplines		

Classes for the participants in special disciplines should be optional in the final phases of the program. Illustrations of occupations and occupational requirements in local industries, as well as relevant occupational information in general, may be provided by visiting representatives from industry, labor, and governmental agencies.

The facilities needed to develop interdisciplinary teaching programs will be determined by the level of teaching (grades or ages). As a consequence, administrative, classroom and laboratory space and equipment will be determined by recommendations of the developmental planning group.

The value of in-service training can be greatly increased by a well-planned follow-up system. Participants in summer institutes or other special programs should associate with a continually expanding program as key persons with responsibilities that extend beyond the classroom. They should expect to receive continuing services at their home bases from many sources and, in turn, provide feedback information. Plans for the follow-up should be built into every in-service training program, and the procedures should be redefined by the participants themselves during the course of the program.

The work of in-service training programs should be documented wherever possible to assist researchers and to facilitate an appropriate evaluation of these programs. Research in this area is extremely significant, and a system should be provided for a feedback of research results to the participating schools and teachers.

If these special programs are to be of maximum value, they must be promoted and given wide publicity. The purpose and potentiality of the program must be understood at all levels, and as much interest as possible should be developed in the program. This requires top level support from federal, state, and local agencies. Key teachers in large school systems – often leaders in the informal school structure – can be invaluable in paving the way for change in programs and curricula. In addition, a system for supplying information to school administrators should be developed. Support from this source cannot be expected unless the information that reaches administrators is comprehensive, accurate and up-to-date.

Pre-Service Teacher Education

Educational change comes ultimately from the professional leaders in the teaching field. A substantial part of their philosophy is acquired in the early stages of the professional education programs in teacher education institutions. Because of the need to introduce concepts of interdisciplinary, multidisciplinary and crossdisciplinary instructional procedures as early as possible in the teacher's professional program, a long range plan for the development of pre-service teacher training is mandatory.

The planning of services to be provided by an institution, in this case a university or college, requires that decisions be made at seven interdependent levels: philosophy, objectives, programs, organization, staff, facilities, and finances. If any step in the planning sequence is overlooked, pre-service teacher education, preparing teachers with new teaching skills for a new kind of program, cannot be accomplished in an institutional setting.

LONG RANGE PLANNING

1. Philosophy – The philosophy from the M.I.T. Vocational Education Summer Study will underlie the planning of services.
2. Objectives – The objectives are derived from the disciplines to be combined by developmental groups.
3. Programs – The programs will include four year curriculums, graduate studies and in-service programs.

4. Organization – A new department or a Center must be developed, and must have its own identity.
5. Staffing – The staff would include joint appointments, associates, fellows, graduate assistants, and consultants.
6. Facilities – The facilities should be located at or near an educational institution that can provide space for developmental work.
7. Finance – Independent funding is necessary.

The problem is to provide the necessary technical and professional preparation for teachers in multidisciplinary instructional programs. In developing a long-range plan for pre-service teacher training, some kind of organization that would provide flexibilty and facilities for developmental work became obvious. Based on the new philosophy, the organization would have to be a new type. It may well be patterned after existing research centers.

The purpose of the Center is to assume responsibility of organizing facilities and programs for multidisciplinary education of present and future teachers. The development of multidisciplinary curriculum content in such a Center will add to the curriculum's effectiveness. Initially, the Center would probably work essentially for in-service training. In summary, the following are general principles of the Center:

1. The location of the Center should be on or near the campus of a college or university.
2. The Center should be a separate entity in the organization of an educational institution.
3. The Center should be organized and designed to draw upon talent and facilities from the best available sources and should not be an instructional division with responsibility for curriculums or for the granting of degrees or course credit.
4. The processes of interrelating subject matter in teacher education programs should strengthen and support the major teaching field.
5. The organization of such a center should be such that it reports directly to top administration. The purpose of this provision is to insure equal availability to all divisions and departments for both participation and use of its output.

Plan of Organization of the Center:

1. Administrative Staff
   Director and supporting personnel (criteria needed)
2. Administrative Council (heads of divisions)
3. Steering Committee – representatives of the schools, divisions, and departments concerned
4. Advisory panel (Board of visitors) – selected for their ability to provide constructive evaluations
5. Professional staff – full-time Assistant Director; Associates – Institutional staff members supported in part from project funds; Fellows (visiting) with temporary appointments; Graduate students; Consultants.

Teachers for the Post-High School Program

The training of teachers for post-high school programs has already become critical because specialized occupational education is moving from the high school into the post-high school area. In general, we are referring to post-high school programs of less than baccalaureate level.

At the present time post-high school programs have obtained many teachers from business, industry, government military services and technical and polytechnical institutions. Many vocational and industrial arts teachers, high school teachers, and college teachers have entered teaching at this level. These sources are good, but they will not fill the demands of the future.

At present there is a serious lack of teacher training programs for post-high school occupational programs. We can continue to supply the post-high school program with teachers from existing sources for the general academic subjects, but we must institute an extensive program for prospective teachers in the occupational fields. In general, our institutions of higher learning have not recognized their responsibility in this endeavor. While they have recognized their responsibility at the elementary and secondary level of teaching, they have found it difficult to identify themselves with the two-year post-high school program teacher. Their problem seems to be one of justifying credit that a student receives in technical courses at the two-year institution as background in his training for the teaching profession.

The Center could serve as the vehicle for preparing teachers for two-year institutions:

A. For teachers of specialized subject matter in occupational fields:
   1. The program should require courses in the teacher's field of specialization.
   2. Multidisciplinary teaching procedures should be an integral part of the program.
   3. An appropriate degree structure should be provided.

4. Optimum use should be made of the services provided by two-year post-high school institutions through a system of earned credit transfer to teacher education programs.
5. Provisions should be made for validation of special competencies in meeting degree or certification requirements.
6. Opportunity for graduate programs in the area of specialization should be made available.
7. Experience in business, industry, or government at some point in the total professional program is strongly recommended.

B. For teachers of general academic subjects such as mathematics, science, English, social studies:

1. A baccalaureate degree is requisite.
2. Advanced study at the graduate level is desirable.
3. Experience and/or training in multidisciplinary instructional procedures is required.
4. Experience in business, industry, or government at some point in the total professional program is strongly recommended.
5. Experience as a student in a two-year college would be beneficial.

Report of the Committee on a Pilot Project for Teacher In-Service Training

July 29, 1965

THE committee members believe, after discussions and listening to committee reports, that education is in need of a new and more flexible structure. With this thought in mind the committee proposes a pilot project involving teacher retraining and their participation in developing new approaches and reshaping curricula.

Our premise is that general and vocational education have the same aims: to provide a base of experiential learnings that will equip the learner to make wise decisions as he reaches points of developmental choice throughout his life. We feel the best approach to real learning would be developed in comprehensive high schools, using the best vocational education ideals, in an interdisciplinary attack on problem solving.

We propose that an in-service teacher retraining program be developed at M.I.T. to train teaching teams from selected junior high schools throughout the country. With an experienced training crew, student needs will be examined, and the many facets of an interdisciplinary attack will be explored and expanded. The development of a curriculum and motivational learning materials will be the responsibility of each team.

The outcomes of the retraining program will be to develop means of introducing the broad areas of vocational education to junior high school teachers, to develop sense-oriented and symbol-oriented learning experiences through articulated interdisciplinary approaches, and to develop means of placing in clear perspective the interrelationships of the basic subject disciplines. The center would continue to receive, process, disseminate and evaluate ideas from the various schools.

If our premise and our proposal are accepted, we offer broad guidelines that may be accepted in total, in part, or in modified form. The areas we have examined and have structured are:

1. Definitions and explanation of words, terms, and phrases
2. The interdisciplinary attack
3. Environmental control
4. Teacher Orientation
5. Administrator orientation
6. Selection of teams and training
7. Curriculum
8. Facilities
9. School and public relations

If education is to be a fluid and dynamic process, innovation must be brought into play and made an intrinsic part of the learning process.

Definitions and Explanations

Teaching Team: The group of teachers and the principal who will be working together to bring the the various disciplines into an interrelationship that will best serve the students.

Planning Team: The teaching team and member of the advisory committee.

Advisory Committee: The leaders in business, industry and other areas of the community who will assist in the development of programs.

Flexible Schedule: A schedule that provides the opportunity for teachers to use blocks of time to serve the students best. (Students may be in one class three hours on a given day and spend only one hour in the same class on the next day(s).)

Choice Point: That time in an educational or vocational career when a decision about future direction may be made.

Articulating Media: The means developed in the center to transmit to students the learning of a new idea, solution of a new problem, or even forming of a new concept by the extension of that learning into various disciplines. The idea to develop the media may be teacher- or student-initiated.

Interdisciplinary Attack

Interdisciplinary teaching is the heart of the entire program. Not only must the teachers meet continually to share ideas and views, but also the curriculum that uses each discipline to reinforce the others must be developed on a cooperative basis.

A strong teacher re-education program is necessary to instill confidence, enthusiasm and a knowledge of working in more than one subject matter area. This program cannot be based solely on a theory-oriented concept, but must utilize talents of persons who have attained success in initial pilot projects.

The curriculum must be carefully evaluated, and the imagination and creativity of the teachers involved will determine the success of the whole project. There will be blocks of time when complete, or even partial, integration may not be feasible, but when the opportunity to correlate is evident, detailed investigation must reveal every motivational technique and device that will excite interest on the part of the student. A prime factor in the interdisciplinary attack is to imbue the student with the understanding that a single discipline does not stand alone; it has tangible relation to all other disciplines as well as to vocations and the work world in general.

Since so little has been done to develop interdisciplinary teaching, a concentrated teacher training education is a *must* before the concept is carried into the classroom.

Environmental Control

Elimination of the current departmental structure is the first step toward strengthening the interdisciplinary attack. Those areas which need to be developed within the junior high school are: communicative arts, performing arts, science and industrial arts, and humanities. Each of these four broad areas might have its own laboratory that would be used by the various teachers and disciplines to reinforce learnings.

Whatever disciplines are to merge in this interdisciplinary attack, the various teachers have to get away from subject-oriented approaches and cross subject area lines. The program will be a goal-oriented, problem-solving attack.

The next control change would be to modify the time-block structure so that students would utilize time on a student-oriented basis. Great care must be used in order to prevent flexible scheduling from seeming hyper-rigid. The time blocks should be in such a sequence that it would be possible to explore in one area longer than one period if such action is deemed necessary.

Teacher Orientation

The general concept that the teacher's interest centers only within his subject matter field has to be changed. The in-service orientation program has to be strong enough to break through the barrier of single-subject ideology effectively.

In the actual practice of an interdisciplinary approach, the most difficult phase is cooperative planning and teaching. Some teachers have the preconception that, since they are not well versed in another subject area, they could not collaborate with real intelligence. This mental barrier is obviated after teachers sit and discuss units and the correlation of these units among the various disciplines. There has to be sincere motivation among the teachers to correlate their areas wisely with the continual thought, "What will best motivate learnings by the student?"

It is a simple matter to discuss correlation of disciplines; it is another matter to practice this concept on a continuing basis. It means teachers have to meet and plan together, seek motivational media and techniques that will implement their team teaching, and always strive to have the students realize the real importance of what they are doing. Correlation in itself is not an end; it is a means to reinforce the various disciplines so that the students reap the greatest possible benefits.

Administrator Orientation

All school administrators must be familiar with the concepts of an interdisciplinary approach to general education.

The school principal must be a dynamic member of all teaching teams. He will also be a member of the planning team, along with the teachers and advisory committee members. He must undergo an in-service training program with the teachers and stimulate constant team meetings to maintain a tremendous interest in the continuing articulative teaching that will constantly develop ideas to best serve the students.

A principal should be so familiar with the program he could step in and assist teams when they are confronted with problems. The teaching team members should consider themselves as guidance workers and utilize the principal as a counselor when the need arises.

Appointment of project coordinators by the principal could result in a more closely knit program. It would be the responsibility of the coordinators to serve as liaison from teachers to principal and to plan team meetings. The principal must plan communications so that a constant understanding of the operation of the program is in effect.

Selection of Teachers and In-service Training

The selection of teaching teams is vital. Before selection for in-service education is made, there should be a briefing session at which teacher candidates would be presented with the ideas of the interdisciplinary approach to education. Those interested in this process of education, together with the junior high school principal, would then be the members of that school's potential teaching team.

Teacher teams should be representative of all disciplines so that the total school is involved. The aims and goals of interdisciplinary education will be examined during the summer work session, and each team will determine the best approach for a particular school and develop learning materials to meet stated aims. Annual symposia should be built into the total program so that successes, failures and motivational media may be examined and passed from team to team.

After a two-year pilot program, the possibility of expansion and means of implementing this expansion should be examined by a special study group. The makeup of any study group should include elementary, high school and junior college personnel to insure that knowledge of this approach to learning and what is learned is known to personnel outside the junior high school field.

Curriculum

Teacher teams must study the current curriculum in order to determine its strengths and weaknesses, areas and units which could be developed on an interdisciplinary approach, and possible additions, deletions, and modifications. The team should discuss the curriculum with an advisory committee of parents and business and industrial leaders in the community. The content should be written with the understanding that it will be dynamic so that it may change as conditions dictate.

Facilities

The Vocational Center may be an adaptable facility or a complex that would be physically designed for an interdisciplinary approach. The center would have sufficient equipment to be adaptable to activities ranging from kitchen science to student level engineering. When the science units call for work in the Center, the team of teachers will have plans to interrelate the disciplines at a high level. All teachers may initiate a unit, but the teachers must correlate all activities. A multi-versed teacher would be assigned as a consultant teacher available to small groups of students and to any teacher with a full class working in the Center. The Center would function in much the manner the school library functions – a service center supporting the various disciplines.

School and Public Relations

Elementary and senior high school personnel must be familiar with the program so that articulation between the levels will be realistic. Educators must make the content, structure and purposes of the program understood by all outside the school.

Report of the Group for a Pilot Project

August 3, 1965

Premise

THE structure of American education which exists today generally precludes vocational aims in the education of any but the trade-training bound students.

Most individuals in our society have a continuing need for the good elements of both vocational and general education in order to prepare for training, employment, advancement, and adjustment to change. However, because vocational education has been relegated to a position apart from and below general education, the intrinsic values which vocational education should contribute to all youth have never been fully realized.

In the broadest sense, the aim of vocational education is identical with the aim of general education. Both purport to provide a base of learnings that will equip the learner for making wise decisions as he reaches developmental choice points throughout his life. The question then must follow: Is it any longer wise to perpetuate a system of education that, as practiced, favors general education and ignores vocational education? It appears that, if education is actually to be student oriented, what is lacking is a pragmatic philosophy for learning which demands the interweaving of each discipline into a pattern of general-vocational education for all youth.

In the light of the premise that the state of American education, with its unrelated levels and tracks, is failing to service the needs of over two-thirds of our youth, it is necessary to analyze and improve the structure that has brought us to our present massive problem.

Foundations for a Philosophy of Unity

To achieve an effective recasting of the structure of educational organization and create a new pattern for curriculum design, specific objectives have to be defined and attained. For example, chief among the faults of the existing educational structure is the complete separation between the so-called academic and non-academic areas. Therefore, the primary objective of any project aimed at eliminating this chasm is to establish a philosophy that demands the interweaving of vocational and general education. To achieve this objective a bold plan for imaginative innovation which does not rely upon established traditions has to be carefully drafted.

The existing structure of education is fraught with vested interests seeking mainly to preserve their separatist domains. Unless these interests can be brought together, any efforts to revise curriculum patterns will fail to achieve their purpose. The drafting of watered-down proposals to appease the system will not accomplish the mission to find ways to reunite all education within the mainstream of American progress. This process demands the re-education of those proponents of separatism whose thinking has caused the hiatus between vocational education and general education. This split within the educational system is at least in part responsible for the tragic lag between education and technology. The direction of such re-education should follow a clear course if it is to succeed. The way is through a coordinated program of instructional materials, development and teacher-administrator re-education.

To organize such a program, a central headquarters has to be established within which a system of input, evaluation, demonstration, training, dissemination, and feed-back can be operated. For about one year the central headquarters would function alone, during which time its operating procedures and program would be worked out.

Strategic settings throughout the nation for establishing regional demonstration centers for pilot projects would be chosen and put into operation the second year. The regional centers would be operated for at least five years by the central headquarters. After that they would be taken over by teacher training institutions and continued as long as needed. The central headquarters should remain in operation beyond the point when the regional centers are phased out of its operations. Since evaluation of the project will require at least a year, the total project span is seven years.

The Target Population

One requirement to assure a favorable environment for innovation is freedom from the restraints of tradition. Though every segment of the educational structure is now operating under some form of constraint, there are areas where resistance to change is more strenuous. At the secondary and post-secondary level there are lobbies that speak for vocational education, university preparatory and other segments of the system. The one area in which no such pressure groups exist is the junior high school.

However, there are signs that specialization into tracks is becoming a part of the curriculum pattern in many junior high schools, a condition which indicates the wisdom of focusing upon grades seven, eight, and nine where division into course offerings has no place.

As a target population, the junior high school offers the possibility of greatest success for developing patterns of interdisciplinary instruction because their biases about subject matter have not generally been firmly engrained.

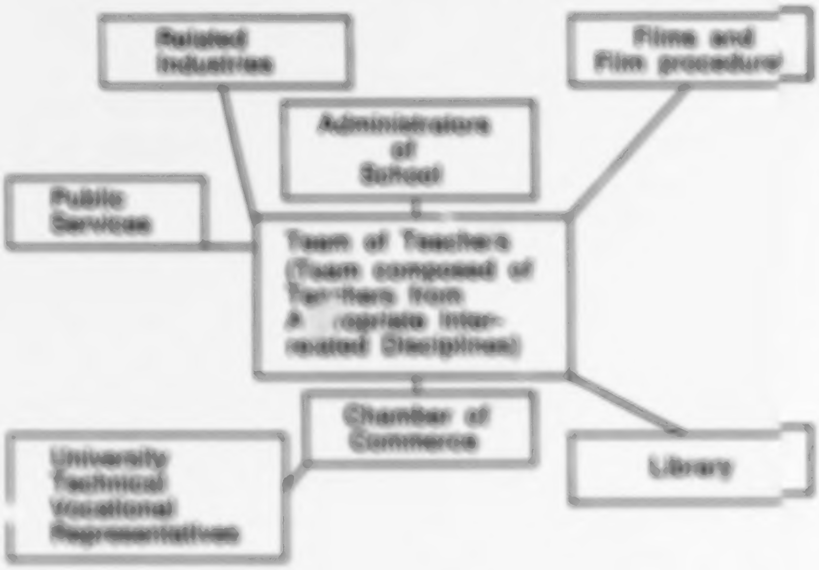
Necessary Considerations for the Teaching Team

THERE is much concern today about the success of education achieved in the classroom. Many postulate that all that is necessary is to have the child doing, discovering for himself, and hence, forming his own ideas. However, that approach is not the complete answer. Today teachers must cease working on islands of their own. Instead, an *interdisciplinary team* approach must be taken. Furthermore, this team of teachers must become more directly involved with the students with whom they are working.

The best method for getting teachers involved in their classroom "teachings" is to give them the *responsibility* of preparing the appropriate subject materials. Working in teams, the teachers can make full use of each other's strengths, and in this way the "fear" many teachers have about developing subject material on their own will be eliminated. By working as a team, the interrelationships between the "traditional subjects" will become more meaningful and consequently reduce the *disjointed nature of learning that exists in many schools* today. This procedure would be further enhanced by including members of the community and related industries on the top team. For example, in developing material on electricity, representatives from the various components of the electrical system such as economics, personnel, maintenance and repair, installation, designers and engineers, and manufacturers of electrical appliances might well become part of a planning team.
The success of this team hinges on some rather important points. The following is intended to be a questionnaire directed toward the team as they formulate the interdisciplinary program for their students:

A. What are the particular goals that *we as a team* have?

Schematic Representation of a Planning Team



B. What are the apparent interests of the students as exemplified by the environment in which they interact?

Considering these two questions necessary to begin the development of worthwhile curricula, the problem of formulating the actual working ingredients is the next step, and it is one of prime importance.

C. What topics, including experiments and activities, can we develop which will best accomplish the goal of interaction implicit in the two previous questions?

D. Can the student, by working with this subject matter, develop ideas which he will find valuable?

E. Does the subject matter lend itself to adaptability to future training?

F. Does the subject matter have the flexibility necessary to recognize the individual differences inherent in all groups of students?

G. How can we develop the topic so that it leads the student to discover the *need* for mathematics, English, quantitative measurement and so forth?

H. How can we develop the subject so that each student develops personal and group responsibility?

If any curriculum is so devised as to satisfy these questions, then every effort must be made to bring the subject matter to the students. The team might well consider the following questions:

What are the minimum materials required and where may they be obtained?

What particular components of the overall material should be taught by the particular teachers on the teaching team?

Where can we appropriately bring in outside people as guest lecturers to explain particular points? For how long should this person be engaged at one time?

What form of scheduling will be necessary?

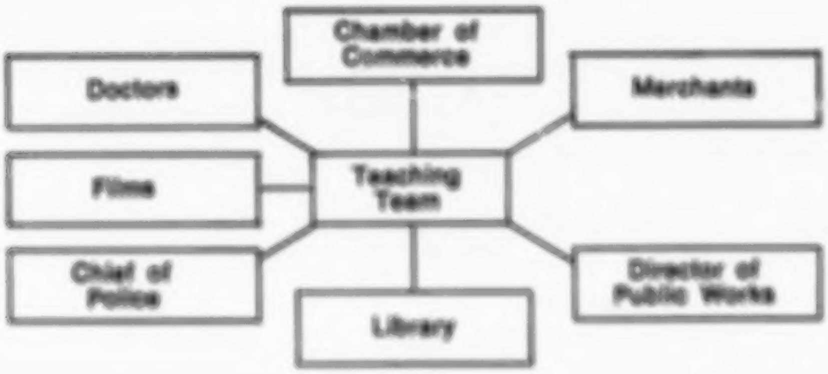
How should the pupils be grouped within each classroom?

The final question to test the overall success of any devised program is: Will our program enable the students to obtain a broad understanding of a part of the world in which they live, as well as a personal sense of their ability to understand, and control this world? To fulfill these criteria is a major goal of vocational education.

Format for Presentation of Subject Ideas to Teachers

1. What concepts may be discovered from this experience area?
2. What intrinsic interests are in the material?
3. What are the minimum material requirements and their availability?
4. *Introduction* explaining curriculum development:
    a. should involve a group of teachers from interrelated disciplines to develop curriculum from the particular environment.
    b. will require teachers to seek outside help when advantageous.
    c. requires a somewhat lighter teaching load and free periods arranged so that a team could confer if teachers are to become involved in their own curriculum development.
5. How can the team teaching be adapted to the material?
6. Can the students learn and retain valuable knowledge from working ((doing)) with this material? By working with this material, can the student develop ideas of value to him?
7. How is this material and experience adaptable to future training and actual social and work situations and experiences?
8. What resources and expert assistance is available in your community?
9. Does your material meet *most* of the following criteria?
    a. Material should be based on a child's natural interests.
    b. Material should employ manual, open-ended experiments.
    c. Experiments should develop interest and competence.

d. Students must *discover* need for math, quantitative measurement and other parts of the disciplines.



e. The student will discover need based on his experiences in everyday life.

f. Material and experiments should avoid the use of confusing titles and names.

g. Material should be designed so that students of all capabilities can contribute significantly to an experiment.

h. The design of the project should enable students to teach each other.

10. Does your activity provide for individual differences and capabilities of the student?

11. The heterogeneous or homogeneous grouping of the students in relation to the subject to be presented should be considered.

INDIVIDUAL REPORT

Memo to Vocational Education Summer Study

August 8, 1965

WHAT follows is the result of my effort to establish a framework. I have felt the personal need, for the effort we are now engaged in, to have a structure which relates facts to understanding. What I have done is to create a framework which fixes a purpose and direction for the set of tributary mechanisms which must be worked out; namely, educating and retraining teachers, evaluating pupil progress, developing specifics of curriculum, achieving flexible scheduling, changing entrance requirements to post-high school institutions, changing education law and ways of evaluating the new education.

Criticisms of Present Vocational Education

Vocational education is at present unduly restrictive and neglectful of the *full* capabilities of students and teachers. Vocational education generally fails to develop the pupil's flexibility. The program of vocational education as it now exists fails to attract many pupils with manual skill and aesthetic sensitivity who do not fit well into the academic track. This is true possibly for the following two reasons. Many of vocational education's course texts consist wholly of machine operation manuals. Thus, the instruction material is akin to a computer program, and the student is reduced to a robot. Second, any so-called "related" programs (science, mathematics, history) are conceived in the limited terms of rules and formulas which are devoid of intellectual content.

In the actual world there are many activities of the individual which are necessary to keep society functioning and progressing and which yield a living. There are also many activities which, aside from yielding a living, give pleasure and satisfaction to the individual. Some individuals find satisfaction, even pleasure, in their jobs. *It is the obligation of our society to prepare its young* for both gainful and satisfying work and leisure.

As the vocational education program exists now, an irrevocable decision is demanded between academic and vocational or between different vocations at a time when the pupil's pattern of needs is still in the formative stage, and he is still very busy adjusting to the world. Many (or most?) of the pre-vocational decisions are approached and handled as a somewhat degrading second choice. This casts a stigma upon earning one's living in a vocation as well as being a student in a vocational program.

The unrealistic teacher qualifications for vocational education are part of the limitations of the vocational program. Because the criteria for these teachers is notably different from that used for any other program of education, a skill-oriented imbalance results.

What Can Be Done?

Vocational education will not be sufficiently improved by merely interpolating a few polished and shiny new ideas into the existing program. While the attempt to work new proposals into the program is expedient for some immediate improvement, the achievement of the long-term goals of vocational education requires a far more probing analysis and a far less simple solution.

To insure the continual growth of any program in vocational education, we must recognize that the ills of vocational education have some deep roots in the educational system. If several basic attitudes remain unchanged, no amount of innovation will affect the underlying weaknesses.

The establishment of a community (class and teacher) and its inevitable social relationships does not preclude the preschool child's instinctive initiative which has provided him with whatever knowledge he has of the world around him. The results of a system which limits the individual are evident when we note that most dropouts are inquisitive, exploring, somewhat indomitable beings apparently undeterred by failure in their trial-and-error approach to life.

In order for this kind of student to find a direction for his abilities, teachers, administrators and parents must learn that curiosity and initiative are not inconsistent with the function of the classroom. This kind of activity should be encouraged rather than inhibited. The student's success and satisfaction are dependent upon the continual development of his individual capacities which may only be discovered if he is free to explore whatever he finds of interest or importance.

The problem of the pupil's decision to follow the academic or the vocational education track raises questions, aside from timing, about his preparation for this decision. *Has he had* enough experience with every possible aspect of living with which he could have been confronted to decide wisely? Placing greater emphasis throughout the school years on the child's manual activity and on his visual, aural, tactile, olfactory and gustatory perception and the exploitation of such perception will give a child the necessary experience in preparation for a sounder decision. In this context, vocational education does not appear as a problem isolated from the rest of education. One could speculate fruitlessly as to why education has forked into a high road – the academic – and a low road – the vocational. Not so long ago the high road was trod only by the clergy and the barristers, for would-be chemists, physicists, biologists and doctors were not worthy of full academic recognition.

I cannot resist speculating a little. The outstanding difference between man and other animals is his highly developed reasoning power and, along with it, his ability to communicate ideas by the spoken and the written word. It is particularly the latter which has served to store, preserve, and make possible the transmission of our knowledge of the world. Thus, it would seem only natural that in the imparting of this knowledge heavy reliance would be put on books. It is natural, too, that speech, a capability we always have with us, should be used as an auxiliary to writing. What such an approach to education fails properly to assess is that our brain development was (in the opinion of many anthropologists) a consequence of freeing the hand from responsibility in locomotion and the development of the opposition thumb. The hand thus became an effective natural tool which opened the world to more penetrating exploration and, as a result, a new evolutionary pattern for the brain.

We know, too, that the development of the human fœtus from fertilized ovum to new-born infant retraces in some degree the evolutionary pattern of man. This process can hardly end abruptly at birth, so that, in continuing to retrace man's development, the growth of intelligence may lean heavily upon the activity of the hand. This theory, on a rather persuasive hypothetical level, lends weight to the point of view that the hand should continue to play an important role in the education of the human child. More decisive than the hypothetical is the observation by many teachers who have tried having the dull, unresponsive, perhaps rebellious, child engage in manual tasks which invite imagination, ingenuity and aesthetic judgment and have found him mentally alive and with the self-direction which was previously lacking.

The use of interdisciplinary units, which are rooted in the child's interests and prior experience and by which interest and experience expand, enhance the child's reliance on the use of his own resources and his ability to reason. The child should mainly be answering "How?" and "Why?", rather than "What?", "Who?", and "When?". He discovers the "What's", "Who's", and "When's" in trying to explain the "How's" and "Why's". These, by establishing an intellectual framework, will enable him to remember the others better.

The new and developing approaches in mathematics, chemistry, physics, biology, English, history, etc., enlist the child in the appreciation and processes of both exploration and building of relationships which are fundamental to the natural sciences and the humanities. The present primary school in particular stifles initiative and wonder in the pupil and gives minimum opportunity for the exploitation of the child's manual and spatial skills, while the exploratory, permissive experimental project evokes initiative and creativity in youngsters, as well as developing manual dexterity. This approach will react favorably on the verbal skill of the pupil in many cases, so that generally the non-verbal junior high pupil of today would be more skillful,verbally tomorrow and would be judged to be less "stupid." The "sharp" pupil would in general improve his manual aptitude.

The pupil should be encouraged to focus on his goals more and more definitely as he progresses through high school. Vocational experience should be provided in eleventh and twelfth grades for vocationally-oriented pupils. At first this experience should encroach only slightly on his regular class activities. However, the opportunity should be ever present to switch from a manually-oriented goal to an academically-oriented one, or vice versa, right up to the twelfth grade and beyond. This flexibility requires that all pupils, whatever their inclinations, be taught in the same building by the same staff. With a spectrum of courses to select from, a pupil could, at the seventh grade, with guidance, adjust his balance between the strongly manual and the academic. The combination could vary in successive terms. The student's tentative goal should not preclude him from taking any course for which he is qualified by prior study or manual experience. Thus, no course is exclusively for either the manually-oriented or for the academically-oriented, or for boys or for girls.

With increasing maturity, increasing academic exposure and increasing manual exposure, the student may well naturally orient toward the goal which is logical for him even before there is any appreciable degree of commitment to either the academic or vocational goal. The first commitment to either an academic or vocational goal would be tentative. The breadth and latitude of both manual and academic work in his high school years should permit a transfer from a vocational to an academic goal, and vice versa.

INDIVIDUAL REPORT

Some Reflections on Vocational Education

THE issue of "vocational OR academic" education has been with us for fifty years or more, ever since a wholly classical education ceased to be considered suitable for the ever-growing numbers of working-class pupils entering public school. Half a century has unfortunately not answered the real question behind this debate (What knowledge best fits young people to live constructively in a democratic society?). But time has at least helped us to see that vocational/academic is not an either/or issue at all. Supporting only one kind will never eliminate the importance of the other, and I believe this fact has important ramifications in two different areas of concern: 1) How students actually learn; 2) What equipment they need for life after high school.

The humanist, whether a professional or non-specialist, often objects to vocational training in secondary school on the grounds that it cheats the child out of several years of fundamental learning that he can never regain in later life. Training, it is assumed, he can get elsewhere later. Therefore, the plan is to *educate* him first and *train* him later. After much wrestling with my own preconceptions in this direction, I have come to the firm conclusion that this is a false perception of the problem and an artificial sequence of events; it occurs largely because we set it up that way, and we do it because that is the way it *used* to be done. We still suffer from a philosophical hangover of the 19th century, believing that whoever is being educated (taught academic knowledge) cannot be trained (taught manual skills) and, vice versa, that using the hand excludes use of the mind or at least is unworthy of the mind.

According to all the evidence I can get, nothing could be further from the truth. Except for the obstacles of time and habit (surmountable), most students could probably learn more "fundamental" knowledge in conjunction with some sort of vocational orientation than without—if we dared admit that the two kinds of learning are directly related.

In my mind it begins with the question of how we learn, how we absorb data and experience from the world around us and eventually learn how to put the pieces together for ourselves in order to do and to think.

The entity we call the "mind" is far more than gray matter and far more than just "intellect." Indeed, the mind is our complete bodily system involving an elaborate nervous and biochemical hook-up with the central brain storage center. The basic ingredients of all thought and experience are electrical currents moving through that system to and from all the sense organs – eyes, ears, nose, nerves, etc. There is more than one kind of mind (sensory-motor circuit). Minds differ initially by virtue of basic biochemical make-up. Minds also differ according to the effects of early experience on those circuits and in what the circuits have stored away in the brain cells for recall and use later on. Some minds perceive literally and directly (visually), others indirectly (aurally); some think concretely, others abstractly. Evidence suggests that these differences are built right into the circuitry. On the other hand, all minds have in common the fact that learning starts by the senses interacting with the muscles and tissue of the body, by touching, tasting, manipulating and responding or acting on the physical world. It can be said about all people that nothing is actually learned (electro-chemical change in brain cells) until something has been done, until a response has searched out and drawn on the stored data and used or applied it actively.

Thus in varying degrees, we all learn to make connections among the bits of data we have stored away; and these links make it possible to recall, to imagine, to create, and to conceptualize. Some students never go very far in this ability to make large leaps between learned elements, and must always reach the abstract through the concrete experience in small steps. Other minds deal easily with abstractions, are retentive and even creative. But in either case, the key is how readily the pupil makes connections among what is available in his stored experience, the process which may lead him to discovery. Since hand, body, eye, and mind are actually part of a single complex system, we can see that the ability to *do* something with the body and hands (motor skill) and the ability to remember and think abstractly are not in fact opposites at all. The use of the body requires the development of the mind; mastery of the body, eye and fingers, is a thought process. Conversely, use of the mind cannot be separated in reality (although it is often in theory) from feeling, judging, using the senses and muscles. Skill and dexterity are, in short, a kind of knowledge intimately tied up with all our other knowledge and feelings.

Some individuals grow up highly developed in both motor and academic skills. Others are decidedly bent in one direction or the other, and still others have ability in neither direction. The boy who fails English may succeed with hammer and nails. However, this success does not measure his "intelligence" but, more likely, the fact that his perceptual system has not been trained to deal with sounds and symbols; there may yet be a route to reaching him. The red-hot mechanic about to drop out may, in fact, be quite capable of excitement about higher mathematics if he can discover a way, and a reason, to learn it (if it can be related to his perceptual and value systems).

What makes the disproportionate emphasis and the wide range of performance among students? Besides the innate differences of curcuitry, this question is usually covered by the jargon of "motivation," which educators so often assume is some sort of gland that the student either has or lacks. If he seems to lack it, there is little that the school can do because he just isn't "receptive" to learning. This subject of motivation is too complex to explore here except to say that, in my own view, learning motivation is a complex blend of metabolism, very early development of sensory equipment and mental circuits, important emotional connections involving past pleasure or pain, and the way a student measures the school's demands and offerings in relation to his own and his group's system: "Do I want to know that? What's that going to get me? Does that mean anything where I'm headed? Will that bring success or satisfaction?" The main reason for learning anything, whether to walk or to talk French, is its relation to ourselves, our needs and satisfactions. Obviously a student's judgment of the meaning of any piece of classroom knowledge is heavily influenced by his ability to understand it, retain it, have insight into it and, in sum, to master it. Success and mastery positively affect his own value system. Conversely, the failure to "dig" what history is all about in relation to himself, or a demand for rote learning without insight into connections, reduces the value of any subject in his value system: "Math is for freaks; French is for the birds," or "Math is fascinating enough for a lifetime." It is true that the families of our poorer students very often distain education as a waste of time and discourage it as a goal because they can see in it no economic justification. It is also true that the way the subject is taught is the crucial bridge between knowledge and student and determines whether it relates and becomes part of him or not. In my mind only a new method will honestly take education across the socio-economic gap and lead students to discover what they need to know.

Our traditional teaching methods and their sequential structure of curricula assumed that a division between a "think" education and a "do" training was right and naturally based on brackets of innate intelligence. Intelligence, largely determined by social factors, was rarely considered potential that has been realized through both the opportunity for experience and the absorption of group values that rank book-learning high on the scale. We know too that learning and education are very suspect or distant goals among much of today's middle and working class – an important factor in the performance problems of students from these homes. These students have an apparent aptitude and preference for "shop" over classroom subjects.

The role of vocational education in the whole learning process might be summed up in the following: The learning of coordination, dexterity, manual and technical skill and personal organization toward a life goal is the gaining of important knowledge and development of a whole sector of the mind. For some kinds of minds, it may be the opening wedge in comprehending and desiring further abstract knowledge and making that meaningful. The discovery and growth of a personal aptitude or area of competence, whether manual or intellectual, is one of the fastest routes to a sense of purpose and motivation in other areas of learning. There is not, or need not be, anything un-thinking about the learning of trades and skills. Indeed constructive experience, visual and motor development and discrimination is essential to the intellectual growth of every student.

Practicality: Do students need it; can schools do an adequate job? As previously noted, the socially-biased structure of our education is crumbling today. Lines are drawn between who does and does not go on to college. These changes have dumped some serious problems into the laps of small and large comprehensive high schools everywhere, and these are some of the unavoidable results:

> –With more students encouraged to go on to post-secondary education, there remains the likelihood that 20% - 40% never will. They must earn a living. No academic or general course equips them to do so, or even to think about it.
>
> –With school laws as they are, a substantial percentage of students must mark time until the legal leaving age, far short of graduation. Dropouts are from the notably unsuccessful but not necessarily incapable strata. They emerge ill-equipped, without direction, and constitute a large amount of lost human potential as well as an economic problem everywhere.
>
> –All of these terminal students and dropouts have a wide range of interests and aptitudes that cannot be served by a single kind of program or preparation. A highly technical emphasis will probably serve a *few* of the boys and none of the girls. A diffuse and low-level industrial arts program will leave the skilled and adept unsatisfied and dulled.
>
> –Performance of students who do go on to college shows that the continuation record is often quite poor; many quit college during the first year, and sometimes only 20% actually complete college. This suggests that there are more terminal students than schools are acknowledging, and a more serious problem of goal-orientation than is confronted at the secondary level.

Question: What to do, or not to do, in secondary schools to serve this particular group of students and their multiple problems?

Pressure against the adoption of vocational courses in the comprehensive high school comes from those who object on humanistic levels – we just can't afford to take the time from other more important things. There have also been objections that emerged in many places where vocational courses are a going affair:

> –Vocational courses don't attract enough good students. All of the college-bound (or those whose parents have such ambitions for them) are scared away from the shop and home economics rooms. For the guidance person, shop courses do not promise enough intellectual challenge to warrant putting boys or girls of "higher" potential into them.
>
> –The kinds of students ending in vocational courses, in spite of their requirements, cannot in fact achieve the level of skill that courses are set up to develop, often for lack of background.
>
> –The skills tend to be specialized, or taught in such a specialized framework that they promise to become obsolete in our rapidly advancing world of technology.
>
> –Vocational and other shop courses provide a haven for anti-academic groups who want an escape from "homework and serious studies." Thus, the student can goof off in the shop and be cheated of his fundamentals.

Accepting all of these as valid observations of existing problems, I cannot conclude that they are insurmountable reasons for entirely discarding *some sort* of vocationally-oriented education for those for whom it is suitable and necessary. Indeed, the irresistible pressure of financial inducement from federal and eventually state sources makes it moot. There is going to be an increasing percentage of vocational teaching in our schools on the half-day basis that qualifies for government reimbursement, and the only choice that is left is *how* we get the greatest educational value from both halves of the vocational students' day in school.

On the positive side, Dr. Conant (in *Slums and Suburbs*) has advanced good and practical reasons that underscore the general advantages of such training to the whole learning process:

–Vocational training reaches the real interests of some students and helps keep them in school. Out of school, out of reach.

–Manual and practical work gives meaning to abstract knowledge by applying it; the shop becomes a laboratory for physics, math, chemistry, etc.

–Development of a personal skill, eye-hand-mind coordination, builds an attitude toward perfection and workmanship that can be transferred to all other learning problems—spelling, figuring, writing as well.

–Terminal students do need job skills and, for most, high school is the only place they will be learned (no matter where they *might* be learned.) In today's social pattern, it may be just as much the school's responsibility to prepare for non-college as to prepare for college.

To these basic reasons I would add the following:

–In being given a chance to develop a manual, technical or non-technical skill, many students will have the beginnings of a serious life goal, which will make clear the need for a variety of apparently "unrelated" learning, especially if the vocational orientation is directly and purposefully linked to the total high school program for that student.

–Being allowed to develop a saleable skill within the school (and a chance to use it in applied work programs) can change the student's value judgment of the whole school program and education in general. School can at last relate to his group values and personal aims.

–If the curriculum for the vocational student is properly set up, it does not knock out his chances of going on to college – and in fact may definitely enhance them by raising his sights and increasing his competence.

Can the two viewpoints be reconciled in practice? Can we meet all the problems that face us—keep laggards in school, train well those who need it, prepare others for higher education, and educate them all in the humanitarian fundamentals that are tools of life in a democratic society . . . all on impossible budgets? It is my feeling it can be done, if we are willing to take a fresh approach, give up the monolithic notion of training *vs.* education, of skill *vs.* knowledge and manage to deal with the many sides of the educational prism as related parts of a whole.

The accomplishment of such a goal will require:

–Programs offering various levels of training, for boys and girls of widely different aptitudes.

–Training that has intellectual content and provides a challenge requiring broad general knowledge related to the workshop course at every turn.

–Skills that are approached as basic principles able to grow and adapt to new and changing job demands.

–Teaching that leads from the concrete and tangible problem to the abstract and back again, from quantitative (what, how much) to the qualitative (why, kinesthetic-emotional) questions, involving the student's whole mental and emotional potential.

–A total curriculum that recognizes the relation of all areas of knowledge and builds bridges between them, assists teachers and students to make these relationships as natural and inevitable as they really are.

Clearly, this program implies a kind of "vocational" teaching with a much broader scope than that which we have known in the past in "machine shop" or "baker's school." It will require, I suspect, some serious curricular study by shop teachers, technical specialists, scientists and humanists to evolve an approach that can do for this field what math and physics study groups have done in theirs. And the work will require a new attitude from administrators and teachers to bring vocational teaching out of its isolation into the learning atmosphere of the whole school. The step can be taken if we find it important to make the effort.

I would not rule out the idea of pushing strictly vocational training to the post-secondary level on a [illegible] a) closely allied to existing secondary schools, their programs, and guidance; b) effectively visible to secondary students as an attainable goal worth staying in school for; c) also available to students on a non-graduate basis – that is, as an adjunct to the secondary shop programs where needed for students who are unable or unwilling to graduate. Until substantial aid is available to bring post secondary programs into being, it seems quite unrealistic to refer to their desirable but nonexistent possibilities as the answer to urgent existing problems within the high school today.

The following specific relationships, not included in this discussion, should be considered:

1) Cooperative experience: the role of on-the-job training in vocational education, relations between school

and industry, ways to increase the learning value for all students from these sources.

2) Choices and goals: the importance of the process of helping the student decide what he wants and what he is fit for, and of assuring that he will have adequate preparation.
3) Flexibility: how to design a curriculum that does not "track" a student relentlessly toward a goal, but allows for slow growth and the change of objectives (hopefully, a raising of objectives toward post-secondary schooling). Also, a program that teaches vocational skills in a framework that will not be rapidly obsolete.
4) Bridge building: the problem of relating subjects (sciences, math, social sciences, self-expression) to skill and trade training; this process is in large measure the problem of relating and recognizing teachers around different goal-clusters.

INDIVIDUAL REPORT

Community Vocational Education

COMMUNITY Vocational Education is needed to help disadvantaged and alienated people who have been historically deprived or devoid of the meaningful connections between education and work.

Teacher Training

The vast number of Negro teachers who are out of work because of desegregation and inadequate training need help. Perhaps such help could develop from President Johnson's idea for a National Teacher Corps and also satisfy the recognized need for retraining people in an interdisciplinary approach.

One consideration of such a program would be the support of teachers in training at $5,500 - $6,000 or some level close to or equal to lost salary. The program might be worked out as a Manpower Development Training Act program in which some would be trained for the shop and work-study approach.

Administration

A system of exchange teams should be developed for either or both industry and schools which are identified as doing a top job. If the interdisciplinary approach or team teaching is to work, the members of the team (including administration) must be involved in some form of training to develop the insight and sensitivity necessary for the new approach to education. The training should be designed to help them see their role as a part of a team. The use of group dynamics from within (not as an observer and recorder as is usually the case with the sociologist, psychologist and social worker) will enable them to respect the position of others.

Areas for Work Study, Shop, or Experiential Laboratory

I. Community Services and Communication
   A. Action Centers which train for community leadership and programs such as Operation Headstart
   B. Cultural centers and community development – Graphic Arts, Radio and TV (Closed Circuit) within school

II. Industry – Shop laboratory – Work-study
   A. Information on the world of work – Unions, career information, etc.
   B. Funding for work-study
      1. O.E.O. Neighborhood Youth Corps
      2. Vocational Education Funds – Vocational Education Act of 1963

      These may have to be run on non-profit basis just to provide frame of reference and experience

III. Business, Shopping Center and Food Services type of laboratory
   A. Could be actual or again non-profit, but there are many economic opportunities in schools such as cafeteria, book stores and others

IV. Health, Welfare and Public Works
   A. Key areas could have hospitals, roads and schools built to provide not only jobs but also a realistic training program

V. Skill Centers

It must be recognized that there are experiences which have not been available as part of the frame of reference of many youngsters to enable them to function in our present school system with greater success. Therefore, it is important to offer them the experiences which would provide the stimulation, new interests and encouragement they need to work well within the operations of the school system. The school system must work from life situations to understand the meaning of these experiences for youngsters. Such experience must be built upon as strengths even though they may initially seem to contradict the accepted middle class frame of reference.

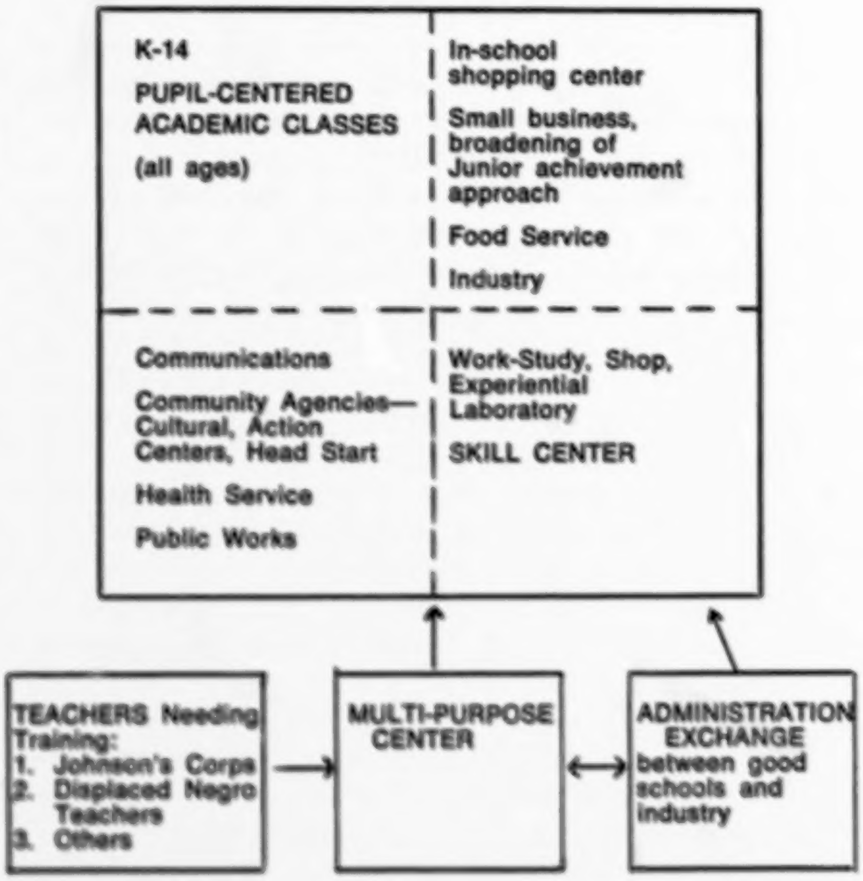
Recommendations

1) Sumer work study programs
2) Greater involvement of community agencies (social work, health, etc.)
3) Special work-study schools for young people and adults who have failed to complete their high school education, operating on an individualized program basis. Students are not penalized for being slow, and adult respect will allow students to qualify for credits based on achievement and not on *time*. These programs should involve industry in the planning and administration.
4) Involvement of these youngsters in the operation of the areas included by the shop and experiential laboratory is crucial.

VOCATIONAL EDUCATION COMMUNITY

Meaningful Education for Entry into the World of Work Support for this program might come from such sources as Manpower Development Training Act, Office of Economic Opportunity, Neighborhood Youth Corps, and the Vocational Education Act of 1963.

SCHOOL—WORK—COMMUNITY SERVICE


K-14
PUPIL-CENTERED ACADEMIC CLASSES
(all ages)
In-school shopping center
Small business, broadening of Junior achievement approach
Food Service
Industry
Communications
Community Agencies—Cultural, Action Centers, Head Start
Health Service
Public Works
Work-Study, Shop, Experiential Laboratory
SKILL CENTER
TEACHERS Needing Training:
1. Johnson's Corps
2. Displaced Negro Teachers
3. Others
MULTI-PURPOSE CENTER
ADMINISTRATION EXCHANGE between good schools and industry

INDIVIDUAL REPORT

Notes and Concerns

August 1, 1965

THE direction taken by the Summer Study will only serve to perpetuate a problem that continues to confront minority groups and the disadvantaged in both urban and rural communities. The fault is not in the goal but in the direction that might be taken to reach it.

A more meaningful approach to education, one that gives young people the skills to be able to learn so that they can adjust to changing technology and the increase of leisure, must be found. However, this approach will not accomplish what it could unless it is directed toward the large group of people who have not found their way into gainful employment because of lack of preparation, lack of skills and discrimination by employers and labor union. Special attention must be given to this segment of the population to help them begin to think about acquiring the necessary tools to succeed in the way the mainstream of society and education requires.

The Summer Study must do more than adopt a philosophy and then a policy which states there is a problem. What we see is only a part of a much bigger problem, and the facts are startling. Even with a rise in the number of people holding jobs and a drop in the nation's unemployment rate as a whole, the job picture for the Negro is worse than it has been. Their unemployment rate has increased about 30% during the last three months. This rate among non-whites went from 8.4% to 9.1%, and the rate is double that of white workers.

Major changes in programs and services have rarely reached or affected Negroes. A clear indication of this pattern can be found in the agriculture program initiated by the Agriculture Department. This program in effect was helping thousands of rural white families to achieve substantial gains in income, housing and education, while Negroes were consistently denied access to the services which were provided.

In the programs of the Summer Study this situation may once again become apparent simply because the programs will most likely affect and promote changes in those areas where there is the greatest receptivity for change. If the programs are only directed toward areas where the concerns about quality education have been foremost and where there is the economic support to meet the challenge of the new kinds of programs, the target area of much of the program will be missed.

Therefore, the major goal, or one that should be at the top of the recommendations, should be that a comprehensive program be launched specifically to combat the problems of unemployment, lack of training and lack of skill found among non-whites. The proposal of a program which will offer new techniques for reaching youngsters in varied places across the community will not solve the problem unless realistic opportunities for jobs are made available. Youngsters must have a meaningful avenue to follow based on what they see done by others who have gone before them. Those who they feel are representative of the problems they face and their background provide the necessary meaningful identification.

Such a program should operate on several levels. Adult education programs, work-study or on the job training programs should be geared toward helping people to get some basic education which could lead to high school equivalence. At least, the tools to get into a training program would allow them to get a job with some degree of stability.

The guidance program will have to be extremely different from the kind offered to the motivated youngsters from more affluent communities who are exposed to people involved in a variety of jobs. The program must be directed toward individuals but also recognize the cultural, social and economic problems that are common to youngsters from a given community. In certain areas of the country problems are created by children having to leave school at various times of the year for crop picking. Some way of insuring that these children are not shortchanged must be found.

The necessity of increasing the school experiences for these children from nine to twelve months is evident. The use of community agencies and services should be sought to involve them in the educational processes needed to supplement their classroom work during the school year.

To begin, a program should be developed to reach the thousands of non-white teachers who are affected by the integration of schools in the south. Many of these people will lose their jobs because of lack of qualifications, in some cases, and others will be unable to get jobs simply because of discrimination. A program which could combine Manpower Development Training Act funds and a special grant might assure these people of a minimum wage of five to six thousand dollars during an intensive training program of six months to a year.

The program would help them learn the interdisciplinary approach and the use of some of the materials as well as provide the kind of sensitivity, training and background required for them to do a job in both rural and urban areas across the country.

This kind of a program would give us a corps of teachers who would be grounded in the fundamentals of an interdisciplinary approach. This training might also lessen the problem of getting more teachers with good academic backgrounds into the vocational or technical aspect of the school program. Those interested in this field would have the opportunity to take courses that would enable them to teach in this field in the schools when they return.

Any approach to an interdisciplinary curriculum will be meaningless unless, as part of the teacher training, a teacher-social scientist is developed. These people must be given the skills and techniques to be able to go into a community and assess and understand its particular needs or problems. Insight into a community is essential so that the materials presented to young people have some real relationship to what is going on in the world of the youngsters who attend the schools. Such a person must understand the community socially, culturally, politically and economically to deal with and present a meaningful approach to the problems and courses in which the youngsters are involved.

Another consideration in meeting the special needs of the non-white, especially in rural communities, is the development of schools included as part of industrial complexes. Where industry is not ready to move into a particular area, a school may have to develop its own industry. This development might work on a subcontractual basis to provide a meaningful work-study program and to equip youngsters with the kind of background and work orientation necessary to succeed in a technical or industrial setting.

Although there are many other ways in which this problem can be broached, I am sure it will not be resolved as part of an overall program. This problem needs special attention, its own focus, if we are going to help youngsters and adults to become employable and, consequently, cut down the spiraling rate of unemployment among non-whites.

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